EXPLORE

Regional Ocean Exploration Workshops

Supporting Data: Volume II

May 31, 2002

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1 Summary

Volume II of the 2002 Regional Planning Workshops Report provides a record of the raw data collected at each of the eight regional workshops as described and analyzed in Volume I.

This volume contains the following:

- Raw data as recorded at each workshop
- A complete table of all Information Need/Gap sort by category and workshop
- A collection of invitee and participant comments in order by workshop
- A complete list of workshop invitees and contact information
- Regional Ocean Exploration Workshop Attendance Statistics

2 Regional Workshops Raw Data

The information contained in the follow tables is the unprocessed data recorded during each of the workshop sessions and provided as a handout to the attendees at the conclusion of each workshop.

Caribbean Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions & Mapping					
Information Need/Gap	What	Why	Where	Technologies	Votes
Understanding of relationship between hydrates and cold seeps/vents and sediment flows and biota (including microbes) and brine pools	discover new species and processes; understand relationships	potential new bioengineering products; serve as areas of production "oases"; ocean resource management (ex. protection of the communities)	hydrate stability zone; 300m - <~3km; northern Gulf; Campeche Banks and Bay; commercial tracts	ROV; AUV; sub; sampling; video; moored application	13
Location and understand gas hydrates	determination of location and volume of hydrate resources; classification; chemistry	energy source; impact on environment (climate, carbon cycle); geohazard/sea floor stability	300m -3km (maybe more) depths; emphasize below 1000m (E. Texas to W. Florida); EEZ; outcroppings; arctic	acoustic mapping; ROVs; sampling systems; video; sub; AUVs; sensors for gas analysis	12
Understand deep water impacts from significant weather systems (ex. Hurricanes)	characterize ocean under severe weather and ocean bottom in real-time	learn of impact on habitats, ecosystems, geomorphology; has not been observed before; benthic recovery; determine if relationship between tracks and water	tropical storm tracks in Gulf	AUV; fixed sensors including hydrophones; sensor arrays	11
Characterize deep MPAs (including deep reefs)	baseline knowledge of existing conditions	ensure knowledge of the constituents that need protection; PSBL Biotech applications	existing MPAs (3 W. FL shelf); Flower Garden Banks	sub/ROV; deep diving capabilities; manned observatory (human habitat); fixed sensors; AUV; good video	10
Interaction between loop current and related circulation features & fisheries	impact on ecosystems and habitats	lack of knowledge related to fish populations; correlation with boundary/events	Yucatan Channel; shelf break along northern & eastern Gulf	fixed & vessel-based ADCPs; tomography; "tailored" AUV; ROVs, cameras, and sampling tools; sensors for ID nutrients; drifters; profilant floats	9
Understanding of Gulf currents on offshore structure	impact on engineering and DESIGN; partnership with platforms	ability to predict loop currents; safety and $$; contaminant control; national security; better understanding	northern Gulf; energy exploration areas	instrumented platform; deployed and fixed current meters; drifters; profilant floats	6
Identify areas that are candidate MPAs	baseline knowledge of existing conditions; ID biota that needs protection; habitat characterization	conservation; impact on surrounding habitat; management and policy	Green Canyon; Mississippi Canyon; Dasoto Canyon; PSBL Yucatan Channe l	sub/ROV; deep diving capabilities; manned observatory (human habitat); fixed sensors; AUV; good video; acoustic mapping (single/multibeam)	6
Interaction between loop current, related circulation, and hydrate stability	relationship between ocean properties and hydrates/beds	geohazards understanding (safety)	loop current and depth <3km; commercial lease tracts	fixed & vessel-based ADCPs; tomography; "tailored" AUV; ROVs, cameras, and sampling tools; sensors for ID nutrients; drifters; profilant floats	5
Understanding of distribution and process details of fluid and gas expulsions, carbonate formations, and seismic activity	knowledge of bottom boundary dynamics	tipper for hydrocarbons (energy resources); fish habitat; geohazards; climate/carbon cycle	slope waters <3km; E. Texas to W FL slope	seisometers; ROVs/subs; video; sampling	5
Location and processes near sites of potential threat to the environment	wrecks; marine debris; dump sites; abandoned platforms	pollution impact; long-term anthro. impacts; safe ty; ecosystem health	suspected debris sites; dump zones; wrecks	acoustic mapping; single/multibeam; sub/ROVs; AWOIS; video; samples	5
Knowledge of sub-bottom characteristics	morphology; composition; dynamics	characterize acoustic backscatter; identifier of hydrate deposits and industry zones	slope waters <3km	acoustic sounders (high resolution, seismic); vertical arrays; AUVs	4
Understanding distribution and migration pattern of marine mammals	response to anthropogenic impacts (noise, other pollution)	conservation; public interest	migration routes; commercial lease tracts (1km contour and loop current events)	acoustic tags; fixed hydrophones; sensor arrays	3
Understanding of loop current related currents relationship to HAB formation and other species tha t are not normally seen	discover mechanisms of transport that leads to formation and distribution	human health issue; economics; recreation industry; impact industry (shrimp, oyster, and fishing)	west FL shelf; Yucatan Straits (source); E. Texas; northern Gulf	remote sensing; towed arrays; ROV/AUVs; sampling; drifters (SVP); HDTV	2
Characterize canyon processes	sediment fluxes; turbidity flow; erosion; chemistry; upwelling	understanding distribution of sediments; knowledge of depositional cycles; impacts on marine mammals and pelagic communities; nutrient production	Mississippi Canyon; Desoto Canyon; Green Canyon	ROVs/AUVs/subs; video; sampling	2
Location and dynamics of archaeological sites of historical significance	wrecks; submerged structures	preservation; creation of habitat; interests the public; maritime heritage	candidate sites resulting from prior surveys	acoustic mapping; single/multibeam; sub/ROVs; AWOIS; video; samples	2
Understand impacts of Mississippi River outflow on habitats, ecosystems (and secondary fresh water input)	Determine river influence on Gulf systems; bio/geo/chem; frontal zones	Regulatory oversight of runoff quality; remediation; impact on fisheries; bottom health; flux of nutrients	Flower Garden Banks to FL Keys	sensor arrays; fixed sensors; AUVs; remote sensing; ROVs	1
Location of new mineral resource deposits	shell; sand	possible economic viability; shoreline protection	EEZ	core samples; ROVs/AUVs	1
Ability to generate energy from ocean renewable resources (currents, vents)	detailed baseline knowledge of candidate currents/locations	possible new energy resources	candidate bathymetry near loop and related currents, vent locations	instrumented platform; deployed and fixed current meters; drifters; profilant floats	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs
Emphasis Area: Ocean Dynamics and Interactions & Mapping
(standard package = class 1 or 2 vessel; ROV/sub/AUV with video & sampling and high speed communications; acoustic mapping capability; precise positioning system)

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
Understanding of relationship between hydrates and cold seeps/vents and sediment flows and biota (including microbes) and brine pools;					
Location and understand gas hydrates; Fluid gas expulsions					
1 - vessel (standard package) + high resolution seismic		biotech products; industry gains (includes safety); ocean management; science; education; homeland security; fishing industry	mod ($$)	3km capable ROV; synthetic aperture sonar; laser line scanner; pressurized hydrate cores; optical spectrometers; mass spectrometers; HDTV; heat flow sensors; resistivity sensors; reusable biosensors	USN; Mexico; Areté; Univ of Miss; USM; Universities; NURC; LUMCOM; NDBC; Canada;
2 - fixed sensors			mod ($ for comms)	vertical arrays; resistivity sensors; sea-floor probes; geophones; time lapse imaging; AUV "garage"	
3 - existing data mining	data bases		mod-low (accessibility)	data recovery technologies	NAVO; NRL; energy companies
4 - remote sensing	surface expression		mod	SAR	
Interaction between loop current, related circulation, fisheries, habitats, offshore structures, HAB formation, and hydrate stability	physical water impacts				
1 - remote sensing	satellite, aircraft	fisheries management (incl shrimp & oysters); better weather forecasting;	mod	hyperspectral sensors	NWS; Universities; NURC; USN; energy industries
2 - vessel (standard package)	expedition to locations/events	safety; economy; public interest;	high	ROVs/AUVs (mobility); HDTV	
3 - fixed sensors & arrays		containment control (structures);	high	ADCPs & CTDs & hydrophones; vertical array sensors; data link	
4 - data mining	existing data bases	national security; human health;	mod		
5 - drifting sensors		science; education; understand & predict geohazard events	high	data link; ADCPs & CTDs & hydrophones; vertical array sensors; data link	
Characterize "deep" MPAs (including deep reefs);					
ID candidate MPAs;					
Location & dynamics of archaeological sites of historical significance					
1 - vessel (standard package)	expedition	biotech products; conservation; management;	high	diving technologies; HDTV; synthetic aperture sonar; laser line scanner	energy companies; NURC; NMFS; Universities; USN
2 - data mining	data bases	education; science;	mod	data mining technologies	NIH; state gov'ts
3 - manned observatory		public affinity; info for enforcement	low ($ & risk)	deep water capability	commercial fisheries; sport fishing
4 - fixed sensors and arrays			high ($ for comms)	time lapse imagery; data link	
Understanding impact of significant weather (hurricanes) on deep ocean					
1 - AUV	not deployed from surface vessel		mod	video; acoustic mapping; hydrophones; chem/bio sensors; AUV range capability; AUV stationed underwater - "wake up"	NWS (HRD); USN; NMS; NMFS; energy companies; insurance industry

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
				Enabling	Partners /
Information Need - Approaches	Description	Key Benefits	Feasibility	Technologies	Available Assets
2 - fixed sensors	data buoys; bottom sensors	risk assessment safety; ability to assess impact on habitats and ecosystems; education; science	high (with current technologies)	time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectrometer; nutrient sensors; data link	
3 - drifting sensors			mod	vertical array (ADCP; CTD)	
Location and processes near sites of potential threat to environment					
1 - vessel (standard package)	(esp. acoustic mapping)	conservation; management; safety; lots of public interest; remediation	high	sampling (bio/chem/physical); coring; video; acoustic mapper; radiological sensor; networked AUVs	EPA; NMS; state gov'ts; NOS (HAZMAT); media?
2 - data mining	data bases	policy; regulation; enforcement;	mod	AWOIS	
3 - fixed sensors and arrays	(when location is known)		high	time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectrometer; nutrient sensors; data link	
Impact of Mississippi River outflow and other secondary fresh water sources on habitats, ecosystems					
1 - remote sensing	space-based; aircraft	coastal zone management;	mod	hyperspectral; ocean color	NMFS; NASA; USN, NOS, Universities;
2 - drifters		fisheries management;	high		commercial fishing;
003 - vessel (standard package)		conservation; public interest; policy remediation;	high	physical sampling; hyperspectral; video/HDTV; towed geo/chem/bio sensors; mass spectrometers	sport fishing; EPA; states; NMS; USACE
4 - fixed sensors and arrays		science; education	high	geo/chem/bio sensors; nutrient sensors	

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Votes
2. Mapping of the Gulf	bathymetry	not done in many areas; slope is an important habitat, resource management, use bathymetry to find habitat fish association - seasonality	slopes, shelf regions, western Gulf off Texas coast - East Breaks area, Eastern Gulf, all of Western Florida, 4 reserves closed to fishing - 2 in Tortugas and 2 in West Florida, Northwest Gulf; partner with Mexico to map Yucatan	multibeam, subs for groundtruthing, utilize backscatter data	15
16. Mapping between known topographic features (goes with #1)	mapping, inventory and characterization	unknown regions	all over shelf	mapping technologies, sampling, ROV's, subs, sidescan, towed systems	2
17. Chemosynthetic communities (subsurface - down several km): oil seeps and vent communities	inventory and characterize, isoloated ridge system, new biota, larger geographic context	unknown regions, new biota, explore why communities exist, what turns these areas on and off?, significant communities through evolutionary time, global importance, genetic links between regions	Cayman Trough - major area to explore - lots of unexplored oil seeps, Southern Gulf, Barbados, Trinidad, West Africa - have some taxonomic affinities to those in Gulf of Mexico	multibeam, geophysical techniques, sampling techniques, satellite imaging, towed vehicles, subs, AUV's, look at new technologies	10
20. Cayman Trough	mapping, plume prospecting, inventory and characterize	significant potential for hydrothermal activity (active spreading center) and not mapped, can do it in a short amount of time	Cayman Trough just outside Gulf	CTD's, multibeam	6
3. Fluid and gas expulsion	map 3-D seizmic data, high resolution data	ID chemosynthetic communities, resource management, what are the controls on the fluid and gas expulsion?	Continental slope, deep water, shelf, Mexico, Cuba, Florida Keys, Florida Gulf	subs and ROV's	4
26. Rivers of warm, dense brine	heat flow measurements, mapping, origin, effects	explore origin and effects, Gulf is a major salt provence	Sigsbee Escarpment, Orca Basin	observations, mapping technologies, CTD, acoustics	1
5. Exploring the deep benthos for biological communities	genomic mapping - non-traditional, cataloguing for biotechnology	biotech application, genetic makeup, resource management	deep Gulf - start at around 200m	genetic technology, subs, box cores, trawls, trapping	8
14. Genetic connectivity of Gulf ecosystems	biodiversity, genomic mapping	resource management, marine bioconservation, recruitment patterns, larval dispersal and distribution, levels of input/ geographic contributions of recruits, Flower Gardens northern most reef system in Gulf	upstream and downstream of productive fishery areas - MPA's, Keys, Banks; major eddy systems	genetic technology, plankton tows, traditional sampling techniques, ROV's and subs, deep water collection	5
1. Distribution and status of deep water corals	diversity, health, size/class distribution, taxonomy	Discover role in enhancing local species diversity; deep water fisheries habitat, resource management	Lophilia Banks - deep coral banks in outer continental shelf-Biosca Knoll, Southern Gulf of Mexico - Sigsbee Knoll and Challenger Knoll	subs, Alvin or deep ROV	4
19. Charismatic megafauna (whales, manta rays, sea turtles, dolphins, whale sharks, etc)	location, distribution, migrations patterns, reproduction, general life history questions, genetics	not well studied, some species are endangered, use of man-made platforms, resource management, outreach/education	Gulf shelf, specific topographic features associated with them, man-made platforms	tagging, satellite, imaging, acoustic, hydroacoustic, genetic technologies	4
23. Lithoherms	map, identify and characterize, geology	Not studied, may find deep corals on them, unexpected discoveries	between Bahamas and Florida	ROV, towed vehicles, AUV's, subs, geophysical technology	3
4. Time observation of topographic areas; revisiting topographic features that have significant biological communities	change in bathymetry, time lapse data	access fish stocks, assessing changes in habitat and populations, species composition, resource management	Florida Gulf and Keys, Pinnacles off MS/Alabama, Northwest Gulf, Mexico	time lapse video to observe activity	2
6. Explore submerged historical and cultural sites - Pleistocene shoreline	Inventory and characterize what's there, record of sea level change	Assess rate of change - based on sea level change, national heritage, how humans and environmemnt responded to sea level change, resource management	edge of Shelf, Bright Banks	sub-bottom profiler, SCUBA, ROV's, subs, sidescan, magnetometers	3
21. Monitoring natural (biological and geological) and anthropogenic noise	effects of human induced noises on biota, natural noise	natural noise can be used as a measurement of health - can be used as a proxy for measurement of animal health	MS Delta where whales are located, human built platforms, protected regions, essential habitats	acoustic technologies, new technologies	3
27. MS canyon river-like structures at bottom	origin, effects,	Not studied, origin unknown, inventory and characterize, potential for unexpected discoveries, Gulf characterized as a brine system - could be global question	MS Canyon	subs, sampling techniques	2

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Votes
18. Canyon systems	microbial communities, geochemical	effects on adjacent ecosystems, unknown microbial communities	Orca Basins, smaller brine pools elsewhere, Gulf	innovative microbial techniques, sampling techniques, chemical sensors, point sampling with ROV's and subs	0
12. Shoreline erosion - Gulf of Mexico	erosion rates, habitat loss, sedimentation, storm surge impacts	public concern, economics, protection from storm surge	Gulf of Mexico, TX, Alabama	remote sensing, aerial photo, satellite imagery, maps	2
10. Hypoxia phenomenon	origin, effects		Gulf of Mexico dead zone, look at all river mouths	collect standard oceanographic parameters	1
11. Subsidence in LA	salt water intrusion, habitat loss, impact, invasive species, impacts on infrastructure	public concern, loss of wetlands and other habitats	coastal LA - most severe there		1
7. Mid-water exploration	characterization of organisms	larval distributions, taxonomy, little known of mid-water regions, charasmatic species, resource management	Gulf, off mouth of MS river - resident population of sperm whales over 1,000m line so there must be a resident population of giant squid, Straits of Yucatan and Straits of Florida - Gulf connections	moch-ness, imagery, sensing, new technologies	2
15. Slope stability studies	debri floats, gas, slopes, faults, gas hydrates, mud flows, inventory and characterization, date features	oil and gas exploration and production, habitat modifying phenomenon	continental slope, Mobile West, Florida escarpment, sigsbee	geotechnical, sidescan sonar, dating techniques, sampling, core samples, high resolution geophysics, multibeam, sub-bottom systems	2
9. Turbid water coral communities	presence and distribution, morphology	emerging field of study, resource management , genetic info, influence of turbid water on benthos	Northern Gulf region, MS River region	food chain analysis, light meters and other monitoring equipment, water chemistry	2
8. Zoogeography of offshore man-made sturctures - oil and gas structures	taxonomy, diversity, distribution	little known, introduced species concerns, effects on pelagic communities (tuna question), biotech applications, resource management	Shelf and deep water, intertidal and subtidal structures	SCUBA, ROV, imaging, standard sampling techniques - collection, modeling	2
25. Exotic invasive species	where do they come from?, how did they get here?, where are they successful or not successful?, impact, taxonomy, genetics	economics, resource management, ecological, can be added on to other projects	everywhere from coast to far offshore regions	standard sampling, genetics, taxonomy, modeling	1
22. Montserrat	hydrothermal activity	active volcano	Montserrat		1
24. Cross Gulf migratory birds	migratory birds - songbirds, contribute to database	not much known, contribute to database, can use existing platform structures, what role does Gulf play in transocean bird migration?, can add bird studies to any other study	Western Gulf mainly, Cuba to Florida	visual observations, radar	0
28. Mega-furrows	origin, physical characterization over time, size, shape, currents	recently identified in Gulf, imact on currents, don't know where sediment goes from erosion	found between 5-7,000 feet - base of the Sigsbee	high resolution bathymetry, geotechnical technologies	0
29. Neuston	identify and characterize	very little information, may be unique with amount of oil naturally occurring in Gulf, biotech applications, pharmacological applications	sites of persistency of oil slicks, Bush Hill - Northern Gulf	satellite, sampling	0
13. Tropical cyclogenesis	air/sea interactions	hurricanes generated in Gulf, short-term warnings	Entire Gulf	offshore meteorology, satellite data, data bouys, ocean observing systems	0
CD ROM on evolution of Gulf of Mexico and talks of Cayman Trough - Tom McGee			Regions to look in - Region around Montserrat (sp?), PR Trench, Cayman Trough, Windward Island, Barbados - mouth to mouth expedition		
Develop new technologies such as in-situ cameras with high bandwidth, antifouling technology					
There is a huge private database for Gulf - petroleum exploration-have to partner with them					
Universal application of GIS technologies					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
1. Mapping of the Gulf					
a. physical mapping - funnel approach; maybe NOAA can fund another group to do this	map, select sites, dives - selectively target between topographic features, subs, AUV's, ROV's; intellectual mapping, time series data	**scientific** - utility of dataset once it is developed, framework for further exploration, discovery of new resources (fishery, bioproducts, chemical, oil); **outreach** - new discoveries, interactive website; **industry** - new resources, fisheries, biotech, oil; **education** - tapping into grad students, incorporate data sets into curricula such as GIS classes	high	standard package, backscatter data, NOAA database	oil and gas industry, MMS, NMFS, siesmic companies (SELL), HARTE marine institute, other existing efforts, USGS, Naval Oceanographic service, sea map, GOMP (EPA), academia, NGO's
2. Chemosynthetic communities					
a (1). Seeps - survey approach	subsurface 3-D seismic surveys, biogeography (sample), go deep	**scientific** - distribution, gas chemistry (plumbing system), biodiversity, biogeography; **industry** - may promote restrictions, resource management, biotech; **outreach** - sexy topic	high	satellite images, oil data, sampling technologies, coring, access industry datasets, chemical sniffers, spectrometers, isotopic work, microbiology, molecular tools, sampling technologies	WHOI, HBOI, NSF, MMS, DOE, NASA, ONR, Universities, industry pharmocology, oil and gas, biotech, Mexico
a (2). seeps - target approach	high probability targets, need to go to the bottom (biogeog), go deep		high		
b (1). Vents - Cayman Trough - targeted funnel approach	locate plumes, then use ROV's, sidescan, AUV's, general mapping	**scientific** - biodiversity, biogeography, key biogeographic provence for global hydrothermal geography, connectivity question, high potential for new discovery; **outreach** - sexy topic; **industry** - biotech, resource management	high	plume prospecting - do multibeam and then use sensors to look for plumes, standard package, geophysical tools, microbiologists, ecologists, molecular science	NOAA - PMEL, NSF - Ridge Project, National Geographic, SLOAN Foundation, International interest, NGO's, USGS, Universities, Mexico, EEZ states
3. Exploring the deep benthos; genetic connectivity; deep water corals	inventory and characterize live bottom communities				
a. soft bottom deep - targeted	deep Gulf of Mexico is most heavily studied soft bottom in world, sampling, trawls, subs, genetics, Gulf is a marginal basin - distinct zoogeographic provence	**scientific** -placing deep Gulf into zoogeographic context ; **industry** - bioprospecting, resource management, habitat mapping; **outreach** - very interesting animals, interesting ecology, sexy topic	med-high	box cores, trawls, subs, standard sampling, molecular tech, genetic, mapping, development of new technologies that are cost-effective	MMS, NSF, standard funding structure, FMRI, Sea Grant, Mexico, Cuba, Census of marine life, NIH
b. hard bottom deep - funnel approach	mapping identifies hard surfaces - can't trawl or box core, so photo, ROV's, subs, geology important; non-chemosynthetic hard bottom poorly studied, looking for topographic highs, lithoherms, lophilia mounds, sink holes - topographic lows - have lots of fish and corals associated with them	**scientific** - characterization, distribution, high likelihood of bioprospecting success, biodiversity, molecular; **outreach** - new communities, sexy topic, can work this stuff into curriculums, video clips on internet ; **industry** - bioprospecting, government NIH, resource management	high	photographic surveys, ROV's (limited with currents), subs, 3-D/4-D seismic, need better sampling technologies and photographic video gear, correlating arrays	
c. time series monitoring	post-funnel, depends on community, new species		med-high	photographic monitoring, in-situ or repeat visits, chemical monitoring, census of organisms with surveys, vertical hydrophone arrays already in Gulf - can hook up with Gulf of Mexico Research Consortium	
Problem in Gulf with meta-data management - need to collect data in useable manner					
4. Charismatic megafauna (whales, dolphins, manta rays, sea turtles, whale sharks, etc)					
a. acoustic tracking (passive - such as hydrophone arrays)	hydrophone		high	aerial surveys, hydrophone, imagery	oil and gas spotters

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies	Partners / Available Assets
b. acoustic (active - such as tagging)		**outreach** - fascinating to public - huge outreach component - warm and fuzzy; **industry** - resource management; **scientific** - distributions, global entities and don't know much about them, how do large man-made structures affect their distribution/migration, reproduction, genetics	high	satellites, various tagging equipment and tech (pop-up, etc), smaller vessels, genetics, endocrinology, biochemistry	recreational fishing communities, big non-profits such as TNC, WWF, Ocean Conservancy, media, BBC, Discovery Channel, academic institutions, industry
b (1). Opportunistic tagging	carry tagging kits on cruises or have on hand in other situations		high		
b (2). Targeted tagging; video/filming species	target at aggregation sites		high	photo equip, ROV's, subs, in-situ cameras, motion sensor cameras, time-lapse cameras	National Geographic
5. Zoogeography of man-made offshore structures - oil and gas structures				standard package - largely diving and ROV's, GIS	
a. dive from rigs, ships with divers	diving, subs, sampling and tech diving, systematically go to rigs	**scientific** - characterization, distribution, invasive species, understanding the role of these structured +/-, how do they affect the life-cycle of fisheries, are they just FAD's; **industry** - resource management, pro's and con's of platform removal, provide other options for platforms not in use, biotech; **outreach** - interesting to public	high	commercial equipment to collect species from rigs, need industrial strength samplers	standard, high potential for industrial partners, Universities
b. recruitment plates attached to platforms	broad scale, formally design		high	low tech recruitment plates	
c. time-based observations	depth is a very important component, systematic approach		med-high		
d. Sargassum mat time-based observations at rigs	modeling, observe before and after mats pass rigs,		med-high		
Because of Sept 11 may have more difficult time gaining permission to approach platforms					

Gulf of Mexico Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions & Mapping					
Information Need/Gap	What	Why	Where	Technologies	Priority
Impacts of Underwater topography (Sea mounts, pinnacles, reef edges)		Baroclinic effects, nutrient production, biological productivity, ID hot spots of biological diversity	warm water environments, banks, shelf edge		13
Knowledge of fisheries habitats	scope and variability of tropic productivity in reef systems	Insufficient scale/depth; define critical path and corridors; including eddies and bio-physical connections	20-200m	single and multi bean acoustics, airborne LIDAR, video	11
Understanding the ecology and oceanography of Florida Straits	Source H2O currents, pollutants, Nutrients, Plankton	Need multidisciplinary knowledge & Coastal Dynamics	Florida Straits, VI, Puerto Rico	drifters, probes, instrument arrays, fixed ADCPs	10
ID and characterization of deep coral reefs		shallows fisheries impact deep reefs and vice versa, can be a biotech resource; ID Relationship between depth and diversity, climate indicators	Florida Straits, South end of Cuba, VI, and Puerto Rico, Marquesas, Lots of Places - beyond >20m	rebreathers, use of ROVs, subs, mixed gas, optics, acoustic mapping, radio tagging	10
Application of new micro/macro organisms on drug discoveries & other industrial products	discover new products		deep reefs, vent, seeps		10
An assessment of biodiversity	microbes, invertebrates	basic understanding needed; potential for applications	coast to the trench		10
Microbial Interactions	Impact on Ecosystems and human & habitat health	Need fine-scale knowledge	reefs		9
Continuous and long-term Systematic Observation	Bio/Geo/Chem/Physical Properties	Need long-term trends, context	coastal area followed by everywhere else	(Fixed and Dynamic) Sensor arrays, remote sensing, omnipresent video, develop low light technology	9
Interactions between abyssal depths and shelf waters (including abiotic/biotic constituents)	unexplored, ID geothermal activity, understand dynamics of nephaloid layer		Puerto Rico Trench and surrounding area	deep submersible	7
Mechanisms underlying Fish aggregations	pelagic and benthic	understanding of dynamics of fisheries and ecosystems; conservation and management	VI, Puerto Rico, Bahamas, Florida Straits, Mexico, Belize	rebreathers, use of ROVs, subs, mixed gas, video, radio tagging	6
Dynamics of interaction between water masses		Insufficient scale and depth, ID impact on productivity	Florida Straits, VI - Anegada Passage; loop current production to Florida Straits		5
Information on Anthropogenic Noise in H2O	ships, blast fishing, Military Ops, Energy Refineries	Impact on ecosystems	Puerto Rico (super port), Bahamas, St. Croix	SOSUS, deployed arrays, ship surveys	2
Impacts of energy conversion activities	Anthropogenic impacts	understand impact on biota	Florida current, deep trenches	systematic obs	2
Additive and Synergistic Effects on ecosystems		How does it affect fisheries?		emerging sensors	1
Connection of separated populations (esp. fish)	How Habitats impact each other	larval transport pathways unknown	throughout Caribbean		
Techniques for characterization on a short time-scale (in the field)		Apply medical tech to marine environment			
sharp topography - no study in warm environment					
Impact of Fresh H2O runoff & Suspended/Dissolved "stuff"	ID and quantity	Impact on ecosystems & habitats - Info on land use activities	All Coastal Regions		
Linkage between marine mammals & food source/distribution (includes vertical migrators)		Migrating instruments			
Anthropogenic impacts on marine mammals and their habitats		ID competition for resources and habitat loss and degradation			
sea mounts, nutrient production, special along reef systems			Marquesas, Tortugas Bank, Islamorada Humps, Riley's Hump,	fixed sensors	
Knowledge of drivers for reef formation	reasons why reefs form in particular areas	management and conservation	Cuban waters	core sampling/analyses	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Emphasis Area: Ocean Dynamics and Interactions

Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies underlined = need to develop	Partners / Available Assets
Impacts of underwater seep topography - seamounts/pinnacles/reef edges					
1 - vessel-based expedition (large vessel)	interdisciplinary observation, sampling, analysis (1m scale, fisheries, maps; microbial scale)	proximity to population centers; biological response	multiple expeditions required; "layered" approach & deploy long-term instrumentation	side-scan/multi-beam; ROV/AUV/sub; multi-freq. acoustics; ADCP - fixed and towed); video (HDTV; 3-D); hyper-/multi-spectral optics (species ID)	AOML; JASON Project; HBOI; cross federal and state entities; ONR: DOI; USGS
2 - standard vessel expedition		highly dynamic regions (ex. Marquesas, west Florida shelf)	exploration applied at the "front end"	air/sea flux measurements; shallow water drifters; remote samples; remote analyzers; deployed genomic monitoring; *develop real-time capability*	
3 - aircraft-based sensors	Remote sensing of surface & mixed layer reflection of topographic impacts	geologic areas of interest (Riley's Hump, Tortugas Bank, shelf edges of VI, Islamadora Humps)	first layer - high	airborne LIDAR; hyper-/multi-spectral optics (species ID); *in situ* ground truth	
4 - satellite-based sensors					
		graduate research areas; understanding of link to bioproductivity; ties to broad area biosystems; value to long-term sustainability (fisheries)			
Knowledge of Fisheries Habitats					
1 - vessel based expedition	class 1 vessel deployment	management; better ability to monitor impact of fishing; other disturbances;	high	standard suite" and develop acoustic techniques for classification (benthic, reef, and water column organisms)	congressional mandate; Univ Puerto Rico; Univ VI; state & regional; territorial agencies & councils; sport fishing; commercial fisheries; NURC; private industry (Ocean Fishing Forecasting Industry); FL Marine Labs (HBOI, MOTE); RSMAS
2 - aircraft	surface and near surface reflection of productivity, habitats, temp gradients, synthetic aperture radar, ocean color	target areas for research;	med	airborne LIDAR; hyper-/multi-spectral optics (species ID); *in situ* ground truth	
3 - space based remote sensing		ID key areas that may need production - "critical habitats";	med	same as aircraft; tracking of tagged fish	
4 - shore based deployment	small craft; coastal apps (20-200m)	ID new fisheries	high	light ROVs, AUVs, single beam acoustics, human diving technologies	
Understanding Ecology & Oceanography of FL Straits, VI, and Puerto Rico					
1 - vessel based expedition	class 1 vessel deployment	ID target areas for research;	high	"standard suite"	
2 - aircraft	surface and near surface reflection of productivity, habitats, temp gradients, synthetic aperture radar, ocean color	ID pollutants and their sources/transport (ex. HABs); ID new fisheries;	med	airborne LIDAR; hyper-/multi-spectral optics (species ID); *in situ* ground truth	state & local agencies; NASA (sat); SFOMC; Navy (NAVO, ONR); Univ VI; Unvi Puerto Rico; RSMAS; local labs; USCG; INS; CIA (DESC); customs; NOPP; OCEAN.US
3 - space based remote sensing		ID linkages between fisheries (including sources, sinks);	med	same as aircraft; tracking of tagged fish	
4 - shore based deployment	small craft; coastal apps	management knowledge and resources;	med (distances)	light ROVs, AUVs, single beam acoustics, human diving technologies	
5 - fixed instruments and arrays	observations and observing systems	ecotourism; feasibility of energy conversion (public generation);	low (cost & risk)		
6 - drifters		Homeland Security; USCG (enforcement); environmental security	high	wide bandwidth communications (via LEO SAT)	
Microbial Interactions (Bacteria, Fungi, Protists, Viruses, Microalgae)					
1 - vessel based expedition	expeditions of class 1 vessels	knowledge of human impact on habitats and ecosystems; drug;	high (not real-time)	"standard suite" and preservation technology for deep samples; real-time remote analysis;	NIH; Public Health Service; Pharmaceutical Industries; global climate community; reinsurance & insurance industry;

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need - Approaches	Description	Key Benefits	Feasibility	Enabling Technologies underlined = need to develop	Partners / Available Assets
2 - shore based deployment	small craft in coastal areas	Public exposure to benefits;	high	genomics; micro-arrays; conversion of molecular data to signals; real-time remote analysis	coastal management organizations
3 - Remote Sensing	use physical/productivity measurements as tip-off information	industrial products; human health; ID candidate research areas;	high		
4 - drifters		impact on global climate;	low (risk)		
5 - fixed sensors		understanding of relationships to pollutants, bioremediation	low (risk)		
Interactions between abyssal depths & shelf waters (Biotic & Abiotic)					
1 - vessel based expedition	expeditions of class 1 vessels	excite the public - "new frontier"; new organisms, biotech development; new products; areas of research; deep H2O impact of fisheries habitats; cultural and historical discoveries (locate shipwrecks); energy resources	med (high with deep dive capability or deployed sensor)	"standard suite"; deep submersible; deep ROV/AUV (multipurpose); surface deployed sampling/analysis devices (cost saving versus deep dive); low light optics	Japan; Russia; France; WHOI (ALVIN); US Navy; energy industries
2 - fixed sensor	bottom based			communications	

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Priority
6 Distribution and status of deep water coral reefs and fish stocks	distribution, taxonomy, abundance, condition, diversity, size	discover role in enhancing local species diversity, compare to known shallow reefs	PR, dry Tortugas, VI, Lang Bank, Shelf bank and wall at VI and PR, Nevassa Island, Columbian Banks	Submersibles, ROV's, advanced diving	16
27 Health and assessment of shallow water coral reefs - need the norms of conditions for comparisons	"Norms" (coral, fish, biomass) of condition for comparison	Major resource, tourist attraction, source of sediment for beaches, center of biodiversity of shallow waters	pan-Caribbean shallow water	visual technologies such as diving, develop new diagnostic or early warning technologies - molecular level technologies, remote sensing	13
3 How do you utilize more effectively, different mapping and imaging technologies to gain the information (large scale low resolution and small scale high resolution)desired					
8 Distribution and nature of submerged archaeological resources	Shipwrecks, prehistoric sites, submerged historical sites; determine nature of site and date it	Threatened resources due to profitability by others; addresses maritime cultural environment and colonial interactions and processes	Pan-Caribbean	All mapping technologies; develop ability to properly core and chemically characterize site; GIS to make successful and broad range availability	11
5 Discover and inventory new living resources (non-fishery) with commercial potential	taxonomy, chemical characteristics, molecular applications	discover and develop new bioproducts	Florida Straits, deep water habitats in Caribbean	submersible technologies; new sampling technologies - new probes, sensors, samplers (miniaturized); advanced diving	10
9 Biodiversity and ecology of marine caves	taxonomy, molecular genetics, mapping, chemical and physical characterization, geology, archaeology, biochemical characteristics	new and relatively unstudied ecosystems, high potential for discovery, critically endangered species, potentially new bioproducts	Bermuda, Bahamas, Yucatan, Greater Caribbean	technical diving, ROV's, mapping and GIS	10
19 Find new vents and seeps (includes fresh water seeps)	taxonomic, physical, same as deep basin	unknown exotic organisms, new insight into the evolution of life, every vent appears to be a bit different	Fresh water communities as well as marine, brine pools, Cayman trench, PR trench, any seismically active area	thermal mapping, salanity measurements, sonar, submersibles, multibeam, technical diving (?) in some of the shallower vents	9
18 Deep basins including PR trench and other Caribbean regions	biogeography, taxonomy, physical and chemical properties, geological work, sediment	unexplored regions	Carribean basins (4), PR trench	submersibles, dredging, visual, trawling, trapping, coring, etc.	8
4 Learn status and habitats of spawning aggregations of fish	distribution, taxonomy, abundance, condition, life history	Very vulnerable to fishing, many already overfished; unique habitats and locations	PR, VI, Nevassa Islands, Columbian Banks (joint treaty)	acoustic work; optical; visual observations, mapping technologies; technologies that work at night	7
Ginsberg - Ultimate clients are those who live in coastal zones; what do these people in the 'summary' want?; not planning a systematic long-term study, just doing pilot projects that would show how we can fulfill the needs of our 'clients'					
Do we need to go back and inventory or go out and find new things? (Craig) Both valuable					
1 Status of fish stocks and habitat on the Islemorada Hump	distribution, taxonomy, abundance, condition, diversity	classically important fishing area; never been explored; been nominated as a marine protected area	Islemorada Hump, Florida Keys	ROV; stereo; digital video; submersibles, drift dives(?) advanced diving; passive acoustics	6
11 Coral reefs, beaches, archaeological sites, and fish, water quality as well - most important - coral reefs	information and define gaps	people relevant, food, economics, tourism	US EEZ; beaches - VI; pan-Caribbean for coral reefs; fish - closed areas and MPA's; archaeological sites Mona passage, Southern Bahamas, Florida Keys, Reef areas in general since lots of shipwrecks occur there	All technologies	6
12 Multibeam mapping of Ocean bottom; Adapt remote sensing from existing platforms and transfer to ocean exploration platforms to increase your sensor array capability	map	set baseline for ocean exploration	US EEZ; ID gaps such as vent and seep communities, drop-offs, trenches, reefs	multibeam technologies, sidescan, bottom profiler, magnetometer, others	5
15 Sea floor sediments Holocene (last 10,000 yrs)	what are they? How thick are they and what events do they record?	essential for understanding the history, sea floor habitats, beach deposits, anthropogenic factors	Florida deep water below 30 meters, VI, PR,	standard geological sampling; acoustics; develop new technologies - lasers, etc.	5
25 All taxa biodiversity inventory	species inventory	Not done	location where there is already a lot of information such as Florida Keys or Salt River Canyon in St. Croix (long-term hydrolab mission)	various sampling technologies, taxonomic expertise, systematics	5
16 Effort on developing automatic signal processing of data; openness with data - make accessible					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Priority
2 Nautical charts from 15th century on - digitize and look at technology and scale to provide historical record ; look at evolution of technology	database - compile current info and map uncharted areas to add to knowledge	historical record of nautical charting, Shows historical progress and current needs	US coastal-wide; make this proposal driven to determine 'where'?	mapping tools and technologies	4
26 Knowledge of the diversity, abundance, and identity of marine microorganisms	taxonomic information, abundance, function, behavior	They are the most abundant organisms in the marine environment, control biogeochemical cycling, Not well understood	water, sediments, organisms, wide range of depths and areas	molecular tech, new culture techniques	3
10 Clearinghouse of existing ocean data and ID gaps; Dating service to connect those who have data with those who want it; connect those who want data with those who plan to collect it or have the means to do so - data library	Database , Lexus-Nexus of Ocean Data	Current means of data sharing are inefficient	Global US EEZ	IT technologies	2
20 Develop better coring technologies with AUV's or ROV's, and make it available					
21 Look at fragile ecosystems such as coastal estuarine regions in a new way so as not to damage them					
13 Deployment of permanent sensors to monitor events over long periods of time- gap is long-time data sets	could be just about anything; acoustic, all practical data types	lack of this type of data	surface and bottom of US EEZ; deeper areas; areas where there is high current flow, Medium sized bodies that are practical to approach	all sensing technologies, AUV's, any platform	2
23 Develop a sampling device to non-destructively sample and do in-situ analysis on that sample; for example - use AUV that doesn't have large payload to use syringe to take sample, run MCLS on it, do molecular genetics on it in-situ; in-situ processing; new ways to sample and analyze in-situ - miniaturized; take lab to ocean instead of ocean to lab					
14 Distribution and description of deep water habitat forming species; what species are forming the habitats? Get a map of the distributions of these habitat forming communities	identification of species and associated communities	these are probably the areas of high diversity and unique diversity counterparts to shallow water coral reefs and may be important for conservation and biological diversity; Doing more fishing in deep water areas - habitat degradation issues	pan-Caribbean	active acoustics, ROV's, submersibles, GIS	2
24 Distribution of marine geographic endemics	taxonomy, distribution, life history	many of the best studied groups have pelagic larval distributions - corals, shallow-water tropical marine fishes; may give us a much better understanding of evolution as well as extinction in the marine environment; applications to bioprospecting and biotechnology	Start at geographically distinct areas such as Florida Keys and compare to US VI	sampling techniques, molecular genetic techniques	2
17 Water/air interface - air/sea interactions - what can we observe on a small scale	biological, chemical, physical processes, tightly focused in terms of what's going on - fine scale	help us understand the uncertainties of global change and other global processes	Caribbean - hurricane source; pan-Caribbean in highly dynamic regions	develop new ones	1
22 Deep Diving and Long Range Marine Mammals	visual, optical, all senses, observe behavior, environment, habitat	unknown, Led us to interesting locations	Wherever they go! Several Caribbean wintering ground basins, nursery areas, feeding grounds	design new technologies - non-invasive and otherwise that follow these mammals	1
28 Exploration in time - how people have used (socio economic, cultural) the oceans in past and how has it affected present condition? Where are we heading?	historical records, Trading Patterns, Genetic Resources, Colonization of the Islands	to assess effect of anthropogenic factors on ocean resources	Pan-Caribbean	standard archaeological techniques, ethnographic data, Zoological techniques	1
Adapt remote sensing from existing platforms and transfer them to ocean exploration platforms					
Are the exploration of the Everglades and Estuaries considered part of ocean exploration?					
How do we prevent treasure hunters from using national maps to rob submerged archaeological sites?					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - ( ) Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
1. Distribution and status of deep reefs and fish stocks					
A. determine where they occur - 30m-70m (technical diving depths) (funnel approach)	Use Bathymetry and Remote sensing to target areas, then make visual contact and dive	map, understanding of extent of deep reefs, inventory, trophic connections - how do they work? Understanding of major commercial fishery habitat to assist in management, education/outreach such as live broadcasts, resource management	High	bathymetry, remote sensing, multi-beam surveys, sidescan, technical diving, ROV's (?)	National Geographic, NSF, NURP, ONR, equipment manufacturers, other commercial operators such as major oil companies, UPR, UVI, USGS, Mineral Management Service (MMS), MBARI, NOAA center in NH
B. Target area and then explore >70m-300m	bathymetry, remote sensing, submersibles		Med	submersibles, remote sensing, bathymetry	Same as above
C. Start with existing knowledge and explore - shallow (targeted approach)	dive boats		High	technical diving	same as above; commercial dive shops, hospitality industry, cruise lines
D. Start with existing knowledge and explore - deep	submersibles		High	technical diving, ROV's, submersibles - location dependent	same as A
2. Health assessment of shallow coral reefs					
A. Well established standard diving techniques	one time visual assessment	scientific benefits - resource management, selection of MPA's, understanding of disease and impacts, biogeography, groundtruthing of remote images; industry benefits - fisheries, tourism, beaches; outreach - sexy topic for public, has potential for grassroot activism, tourism	high	SCUBA	tourism agencies, hotels, hospitality agencies, National Geographic, private foundations
B. Remote sensing	Aircraft and satellite sensors distinguish between dead and living coral		low	hypospectral techniques, aerial photography	NASA, NOAA, National Guard, Coast Guard, Navy,
3. Submerged archaeological resources					
A. Shallow water (funnel approach as well as targeted; non-invasive commercial exploitation)	Survey then standard diving and archaeological techniques same as shallow reef (2. A)	scientific - seabed mapping, shipwrecks are niches in and of themselves, potential for finding unique sites and resources, new insight into history and pre-history, new insight into development of technology; outreach - video clips, artifacts, inquiry, resource is 'sexy'; industry - non-invasive cooperation of commercial industry, enhancement to tourism and associated industries, museum displays	med-high	standard diving, acoustic, magnetometer	National Endowment for the Humanities, NSF, NGO's, National Geographic, private and corporate partners, affinity groups, Discovery Channel - media, academic partnerships - FSU, MIT, WHOI, TAMU, William and Mary, Univ of Bahamas, UPR; NURP, Smithsonian
B. Shallow Water Targeted Approach	Use historical records to select sites, then use standard diving and archaeological techniques		high		
C. Shallow Water non - invasive cooperation	cooperation between science, commercial, management to explore archaeological resources		low		
D. Deep water Funnel Approach	Survey then technical diving, ROVs, SUBs, and archaeological techniques		low	Add technical diving, submersibles, ROVs	
E. Deep Water Targeted Approach	Use historical records to select sites, then use Technical diving, ROVs, SUBs and archaeological techniques		medium		

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - ( ) Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
F. Deep Water non-invasive cooperation	cooperation between science, commercial, management to explore archaeological resources		low		
4. Discover and inventory new living resources (non-food species) with commercial potential					
A. Site Identification		science - discover new species, genetic and chemical diversity, bioactive compounds, new bioproducts, understanding role of compounds in nature; commercial - bioproducts, public disclosure of data; outreach - sexy topic, media coverage		bathymetry multi-beam and side scan	pharmaceutical industry, biotech, medical manufacturers, equipment manufacturers, USDA, cosmetic companies, NIH, NSF, NURP, Sea Grant, MBARI, WHOI, NASA, NCNPR, HBOI, SIO, UH, Smithsonian
a. Funnel Approach	High Resolution bathymetry to map deep water hard bottom areas. Use this information to identify sites		high		
b. Targeted Approach	Use Existing Maps to identify sites		high		
B. Sampling					
a. 30-150m	Tech diving and manual sampling		med-high	tech diving, manual sampling, develop new sampling tools and new tools to keep samples alive (high pressure, low temp containers)	
b. 150m to bottom	submersibles, ROVs, AUVs to collect samples		medium	develop new sampling tools as in above, submersibles	
5. Marine caves					
A. Approaches for Identifying Caves		scientific - new species, higher taxa, living fossils, most species endemic, potential for new life forms, potential links for deep sea, biogeography, evolutionary questions, genetic diversity, endangered species and habitats, archaeological discoveries, potential for chemical, geological, physical discoveries, new bioproducts, sea level history, tectonic info; industry - bioproducts, tourism; outreach - way cool, high adventure and high risk, exotic and historic artifacts, classic form of exploration - cave divers called explorers		technical diving, cave cam, develop new tools, all traditional sensors for collecting oceanographic properties, remote sensing, satellite and aerial photography, topographic maps, speak with cave divers, geological maps	diving - commercial operators such as charter boats, cave divers, fishermen, hunters
a. dive	visual observations while diving		H	technical diving	
b. oceanographic properties	look for chemical and physical signatures		H	traditional sensors, satellite photos, submersibles	
c. multibeam	ground truth with other methods to look for patterns		H	Multi-beam	
d. local knowledge	speak with locals		H	cave divers, fishermen, hunters	
B. Approaches for Exploring Caves					
a. Shallow (above 70m) and large (at least human size)	cave cam, AUV, remote samplers, drilling		high	GIS mapping, cave cam, drilling, data processing and visualization tools, sampling technologies, AUVs, Remote Samplers	
b. Shallow (above 70m) and Small	shallow small - cave cam on flexible cable, drilling core holes;		med - high	Same	
c. Deep (below 70m) and large (at least human size)	and add remote sensing; large deep ROV's,		med - low	Same (no diving)	same as last one and add taxonomists, many universities and museums all over world
d. Deep (below 70m) and small	small deep same as shallow small		med	Same, just different platform	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Observation and Mapping					
Information Need - ( ) Strategies	Description	Key benefits	cost/risk Feasibility	Enabling Technologies	Partners / Available Assets
C. Tie into geological drilling projects or other existing work to find micro-caves (partnerships with existing efforts)	find out who is doing what, and get the remains of core samples and work		med	coring, smaller tools (bore hole size)	Same add taxonomists
6. Vents and seeps					
A. Identification	same as caves but watch temp more	scientific - similar to caves and living non-commercial lists, unknown; industry also same but commercial benefits are less; outreach - way cool, earth's processes, water/land interface in the ultimate sense, great extremes	med - low		
B. Explore	time series photos, physical, microbial, chemical, biological sampling, detailed mapping		high	ROV's, submersibles AUVs, deployment of platforms that stay in place for long term monitoring, some new development of tools and platforms, cameras	same as last one but less commercial more foundations, possible oil and gas
7. Deep basin					
8. Spawning aggregations					
9. Fish stocks and habitats					
10. Coral reefs, beaches, fishes, archaeological sites					

Hawaii Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interest
Understand the Pacific Ocean regarding the origin of life (vent communities, any optimal environments, etc)	interaction between geology, biota, circulation	Identify genomes - microorganisms, understand survivability, macrofauna and ecosystems, leads to detecting life elsewhere, relates to ourselves; how does life create itself	Loihi - volcano, hot spot; Juan de Fuca; cold seeps; Back Arc Basins (Guam, Samoa, Lau)	standard ships; ROVs; subs; sampling and incubation systems	11
Marine biodiversity - inventory from Hawaii Islands	link investigators to coordinate	identify diversity; over fishing issues; biomedical opportunities; fishing issues	NW Hawaiian Islands to compare species; deep ocean areas	observatories at depth; deep ocean sampling instruments; low light cameras, video; acoustics; AUVs	9
Characterization of bottom habitats	match fish species to bottom characteristics; collect ground truth with deep tow side scan sonar; seafloor sediments characteristics; bottom currents	fishery population; food web; stock assessment (tuna issues)	Samoa; Marianas Islands	ROVs fly through; canyon fishing	7
Locating unknown seamounts	verifying location; sampling; mapping	spawning habitats; Earth evolution history	start comparing altimetry w/ nav charts	altimetry maps; swath bathymetry; fishing boat watching	7
Deep seamount biomass understanding	sampling; deep scattering layer over hydro plumes	spawning habitats	West Mounts; Neckeridge; Hawaiian Islands; Musician Seamounts		7
Gaps in exploration in past of arcs	less than 2% been explored; location of chemical fluxes and plumes; biotas; volumetrics; geologic signatures; tracing ocean circulation; sensing water column	plate tectonics, submergence, divergence, what initiates subductions; impact on variations on biomass and climate; mineral resources	euphotic zone in Tonga Kermadec Arc	ships, ROVs, AUVs	7
Understand habitat of large pelagic animals - migration corridors, use of ocean, vertical movements	attach instruments to animals - movements; fronts, eddies; interaction with benthos, linking foraging with physical environment	better management of living marine resources; fishery link between population and food source; mercury source	central Pacific (around Hawaii); coastal Kona (Big Island); ship of opportunity; Hawaiian Ridge	technologies attached to animals - archival tags, pop up satellite tags (PSAT), video; ARGOS	7
Natural history of Hawaiian Islands; geological controls on marine biota	what we don't know - seamount biology, why islands all different; geophysical history; how it ties into current optimal and extreme environment; landslide collapses; anthropogenic influences	how were they formed; future of human's impact; survival of islands ecosystems; speciation between islands	Hawaiian archipelago; surrounding pelagic waters; NW Hawaii - French Frigate Shoals; SE Hawaii - Big Island	multiplatforms; mobile observatories	6
Understanding biomagnification of pollutants and toxins in the marine food web (similar to large pelagic)		food source; nutrition; public health; ecosystem health	Kona coast; Ecuador; Peru; Alaska	tracers; genetic markers; sampling and ID tools; stable isotopes	5
Sample and map new hot spots; fundamental understanding	sampling deep mantle plume; sample volcanic edifice edge of seafloor	chemical fluxes; heat fluxes; Earth survivability; source of potable water	Samoa; Loihi	SOSUS; Isla - Infra Sound Lab (U.N.); bring back Hugo	5
Climate Change - feedback of ocean change on biota	studies in tone with El Niño events; long term; carbon fluxes in thermocline	impact on biological pump	Equatorial Pacific S. America; Galapagos; Toca Tao Arrays	genetic sampling; satellite (remote sensing); mass spectrometer; sediment traps/cameras	4
Trenches	gas hydrates	life under great pressures (barophiles)	Marianas Trench; Tonga Trench	deep diving vehicle	2
Data management of collected information, samples, etc - Directory (OE Catalog)	web sources; publics; displays; satellite links; presentations	information to the public	Bishop Museum; HURL; Reef Talk	video data management system; internet; sample catalog	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
Emphasis Area: Ocean Dynamics and Interactions	"standard" partners - UH, State of H, NMFS, NOS, NMS, USCG, Bishop Museum

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Understand the Pacific Ocean regarding the origin of life (vent communities, any optimal environments, etc)					
1 - Funnel (including Tow-Yos)	area to target (Tow-Yos - sampling in vertical)	mod ($$)	standard + specific sampling, HDTV, digital camera systems for culturing organisms	JAMSTEC, Univ of Washington, PMEL, NASA, GNS, COMB (Center of Marine Biology at Maryland)	genetic origins; biotech products; understand modes of life; outreach and education
Marine biodiversity - inventory from Hawaii Islands					
1 - Deep Marine (>200m - ~6500m or beyond)	along and around Hawaiian Ridge	mod ($$)	deep submersible; ROVs; benthic observatories	JAMSTEC; standard partners; ONR	preservation of species; outreach & education;
2 - deep ocean observatories	targeted at ridge; long term	mod (high tech challenge)	*insitu* observatories; self cleaning camera lenses	standard partners	understanding of wide environments; obs in natural environments;
3 - animal borne instruments	targeted and obs. Approach	high	critter camera technology; rugged low light cameras	National Geographic; NMFS; US Fish & wildlife services	marine mammal survivability; marine life/ecosystem management; ocean foraging
Characterization of bottom habitats					
1 - funnel	broad scale characterization	high	ROVs; swath; deep tow; remote sensing of shallow areas; acoustic surveys	Navy; WHOI; U.H. Mapping	stock assessment; fishing industry; understanding essential fish habitats
Locating unknown seamounts; Deep seamount biomass understanding					
1 - funnel	altimetry mapping comparisons; geoid products	high	better altimetry sensors and data processing; improved spatial coverage	NESDIS; NASA; Navy	mapping for fishing industry; earth science; Pacific plate evolution;
2 - target individual seamounts	moored stations; deep dives	mod ($$)	standard package; bio sampling; gravity survey; deep tow; AUVs	Navy	new fisheries; understanding fish spawning, topo. Bio. coupling, foraging, upwelling; fish migrations
Gaps in exploration in past of arcs					
1 - Tonga Kermadec - funnel, target, obs	standard plume techniques	high	airborne remote sensing surveys; XBTS, high precision; standard package, tow-yo	PMEL; GNS; JAMSTEC; NSF - ridge program;	mineral resources; plate tectonics; variations of biomass; oasis of life
2 - follow on obs. approach		high	ocean observatories	American Samoa; NMFS; NMS	
Understand habitat of large pelagic animals - migration corridors, use of ocean, vertical movements					
1 - targeted & observational	commercial/research vessels for tagging; satellite data comparisons for behavior patterns; acoustic subsurface surveys (foraging)	high	critter camera technology; satellite archival tags; ARGOS; remote sensing; acoustic surveys; instrument research	fishery council; Hawaii Long Line Assoc; National Fish & Wildlife; National Geographic; NIWA (New Zealand); CSIRO (Australia); SPREP (S. Pacific Reg. Env. Prog.)	fisheries industries; stock/resource assessment/mgt; international cooperation
Natural history of Hawaiian Islands; geological controls on marine biota					
1 - targeted	includes shallower water; land based influences; effects of high island; altimetry mapping comparisons; geoid products; hyperspectral surveys; high res. seismic surveys	high	standard package; airborne hyperspectral surveys; ground truthing	JAMSTEC; NOS; USGS; standard partners	marine resources; better maps; hazards issue
Understanding biomagnification of pollutants and toxins in the marine food web (similar to large pelagic)					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1 - observational	reef fishes; quantifying toxins	high	tracer technologies	EPA; standard partners	fishing industry; health; education
Sample and map new hot spots; fundamental understanding					
1 - targeted	investigate Loihi, Samoa, Louisville Ridge	high	standard technologies; ocean bottom observatories; SOSUS, Sonobuoys Ocean Bottom Seismometer; Acoustic	USGS (Hawaii Volcano); GNS	understanding chemical fluxes, biomass
Climate Change - feedback of ocean change on biota					
1 - observational	time series with El Niño events: determine impacts on equatorial Pacific biological pump; long term	mod	fluorescent signal of phytoplankton species	standard partners	understanding biotic feedbacks on climate change; predicting/modeling changes on impacts
Trenches					
1 - targeted	Tonga Trench; deep dive mapping	high/mod	extreme deep diving for ROVs; sampling tech	JAMSTEC; NSF - Margins	plate tectonics; new species; subduction factory
Data management	develop catalog coordination; central catalog, clearing house	high	internet; digital process annotation	everybody	outreach and education

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Interest
23. Specific geological features					9
A. Submarine canyons	carbon cycling, areas of high productivity, ID and characterize communities, maps	not studied, area of high productivity, potential fish nursery habitats	Kaneohe Canyons, Haleiwa Canyon, Waimea Canyon	subs, ROV's, bait deployment, mapping	9
B. Seamounts	ID and characterize communities, ID new species	potential for new species - high speciation so could contribute to question of where species come from, potential stepping stones for species dispersal, evolution question	NW HI to start and then look outside to examine dispersal, evolution, many seamounts have no names, Emperor Seamounts		9
C. Solution Basins			off Maui		9
D. Banks			Penguin Banks, NW HI Banks		9
14. Current patterns and gyres and how they are changing	food production, marine debris deposits, how do they change and how are they affected?, larval transport	changes in ocean currents affect many things such as distribution of larvae, if can get a better handle on predicting changes, may be able to counteract problems associated with changes, fisheries management, early Polynesian navigation knowledge, cultural knowledge regarding dispersal of early Polynesians	HI Archipelago - large system focus	satellites, time observations, floating instruments, physical oceanography, molecular techniques to look at long-term dispersal patterns	2
13. Internal waves	physical oceanography, internal tides	how do these tides affect currents and impact distribution of marine life, mechanisms of upwelling, not well understood, may use this info to detect where coral beds and other suspension feeding organisms exist	sea mounts - 2002 proposal sites	ADCP's, long-term moorings	1
8. Paleoshorelines	sea level information such as history, finding wave notches, ledges, other geomorphological features, lava tubes and marine caves - biology	get a handle on sea level history, management - habitat as well as resource, chain is undiscovered, gain insight into rise and fall of islands	HI Archipelago (focus in NW and main islands - Midway, Oahu, Necker, main island, Brooks, Lisianski)	coring technology, advanced diving, subs and other vehicles, multibeam for mapping, animal borne instrumentation	5
18. Understanding population from geological records	fossil records, population over geologic time	better limits of yield	Kaneohe Bay		

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Interest
19.Extinct species (fossil reefs)	carbonate samples, date, taxonomy	evolution insight, biotechnological application	deeper the better, NW HI, Emperor Seamount chain, Kure and other seamounts up the chain	subs, manipulator, sample collection	
17. Marine parasite lifecycles	documenting parasites, life cycle, primary and secondary hosts	little known about them, bound to find new species	compare regions to look for pollution relationships, NW HI	fishing, sampling technology, subs, genomics, histopathology, specimen collection	3
15. Pollution and marine pathogens	pathogen count as a marker	organisms getting sick, human impact	event driven, Kaneohe Bay, Pearl Harbor, sewage outfall	molecular biology techniques, genomics	1
1. Submerged archaeological sites	location, material remains, priority areas, identify microbial community of sites to determine age, dating, erosion control, biological climate, identify and catalogue biological community	historical significance, to eliminate potential for activities that might jeopardize artifacts such as looting, dumping, etc, Federal Abandoned Shipwreck Act of 1978, looting a problem in Hawaii, ecological impacts, tourism	Kure Island - one of most significant wrecks in Hawaii - Naval Historical Center probably interested in this site; protected zone off Pearl Harbor - several subs there - historic landing sites; Nihoa Island and Necker Island; wider Pacific; US Insular Pacific; Hawaiian Islands - Oahu, big island Hawaii, Kure, Pearl Harbor, Midway, Lanai (shipwreck beach)	side scan sonar, magnetometer, technical and advanced diving, ROV's, subs, aerial survey or remote sensing, technology dependent on location and type of wreck - later. . . excavation, conservation, and display - need conservation facilities, microbial technologies, microchip technology	12
5. Animal distribution patterns	all life stages - larvae through adults, population structure, corals, charismatic megafauna (sharks, whales, dolphins, seals, sea turtles)	resource management, because they are there, connectivity questions, tourism	HI Archipelago (Hoomalu and Mau regions - have at least one site in each region, also big island site), specific relationship between main HI and NW HI and between Johnston Atoll to S. Japan, island to island, bank to bank relationships	tracking devices, genomics, develop new faster genomic technologies to be used on ships, current meters, ADCP's, molecular techniques to ID larvae, video technology, time lapse photography	12
3. Identifying ecologically critical habitats	diversity, location, substrate type, visual information, reflected imagery, community structure	some will be important to fisheries, to protected species, establish links to undersea landscapes	intermediate depth regions, wide range of depths - mostly moderate depths to deeper depths, NW HI Islands - 2002 sites as specified in 2002 proposals, US Pacific Insular Islands, Guam, Samoa, CNMI	archival capability, current meters, ADCP's, multibeam . . . Same as above, tagging technologies	9
4. Formation of biofilm/microbial mat in extreme environments	diversity, members of consortia, genome mapping, discovery of new antibiotics, chemistry of the environment	origin of life questions, biotechnology	Loihi hydrothermal vent, New Zealand, Marianas Trench, any extreme environment	coring technology, genomics, protein chemistry, microchip, confocal microscopy, develop portable confocal for ship use, small gc/ms, subs and other collection vehicles	8
2. New species/records inventory	abundance and diversity, taxonomy	very little is known about this region and it is now a huge reserve, beginning sanctuary designation process, bioprospecting, may need additional levels of protection on certain rare species - management	NW HI (2002 proposal sites) - far islands such as Kure and beyond where there have been no subs thus far, get close to N Pacific transition zone, US Insular surveys, maybe look at some equatorial areas for comparison	same as above with multibeam added	6
10. Active volcanism	ID sites, composition, geological properties, biological properties, chemical properties, plume characteristics	sites of very interesting organisms - extremophiles, geological interest, creation of islands	Am. Samoa, New Zealand, Japan, CNMI, Guam - throughout Pacific	thermal technology, magnetometers, seismology	5
6. Ocean acoustics	unique species fingerprints	benthic habitat, describe acoustic landscape including inverts marine mammals, etc, calibrating, unknown	HI Archipelago (NW and main HI mapping), Guam, CNMI, Am. Samoa, deeper areas	sonar - active and passive, use subs and other vehicles for insitu measurements, archival measurements	4
21. Ecosystem interactions	trophic level interactions, define where gaps are	to better understand for ecosystem management purposes	primary productivity to infauna	will vary, stable isotopes, fatty acid analysis, modeling	4
7. Library of community DNA	DNA archive	can collect this info during cruises	all communities	DNA storage technologies	3
9. Mineral resources	location, composition	resource management, commercial value, can contribute to knowledge of geologic history	Johnston sea mount, other sea mounts	subs and other vehicles, multibeam	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
16. Charting of seamounts and banks	mapping with more sophisticated technology	Some NOAA charts are not accurate	all submerged banks, particularly those that can't be seen through aerial photography, NW HI at 25-100 fathoms	multibeam	3
24. Coelocanth, giant squid, megamouth (obscure, unknown critters)	location, habitats?, population distribution, abundance, genetics, images	exciting new species, know nothing about them, future funding and outreach - PR, evolution questions	Indonesia (coelocanth), HI, California (Pacific) (megamouth), New Zealand (giant squid)	imaging, subs, ROV's	3
22. Marine viruses	what effects on carbon and phosphorus cycling	to understand their effects on carbon and phosphorus - looks like they may take up all the phosphorus	Oahu, Station Aloha (permanent sampling site - mooring)	water sampling, virology, bacteriology, molecular biology techniques	2
11. Locating and removing unexploded ordinances from coastal regions		there are lots of 'bombs' in coastal regions and Navy is all talk and no action on subject			
12. Safe nuclear waste disposal site					
20. Infaunal organisms	taxonomy, sediment ecology	discovery of new species, not well understood, relates to carbon cycling	compare NW HI to others down chain, different depths, soft bottom	sampling, multibeam, coring, subs, diving	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
Emphasis Area: Observation and Mapping	tandard partners for State of Hawaii - UH, NMFS, DLNR/DAR, NOS, Sea Grant, HURL, West PAC, Bishop Museum, DOE, Fish and Wildlife Service, Navy Historical Center, National Park Service, USGS, Coast Guard, ONR, NSF

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1. Submerged archaeological sites					
A. Near-shore low impact visual survey - Targeted	historical research, archives, non-invasive documentation	H	small vessels, aerial survey	Standard plus the following: Naval Historical Center, National Park Service, National Geographic, Discovery Channel, DOI, State Historic Preservation Division, Hawaii Historical Foundation, Hawaii Community Foundation, Bishop Museum, CMAR, other small NGO's, Smithsonian	**scientific** - in state and federal laws that historic vessels are to be protected; **industry** - tourism; **outreach** - lots of public interest, education, stewardship of cultural resources; **regulatory** - protecting areas
B. Mid-water remote sensing	documentation to narrow down to select survey areas, groundtruth targets	H	vessels, sidescan, conservation ability		
C. Deep water	survey targeted areas then groundtruth	M	standard package, conservation ability		
2. Animal distribution patterns				Standard partners plus fishermen - recreational and commercial	**scientific** - new knowledge, don't have a good handle on larval stages, biogeography, connectivity; **regulatory** - management; **industry** - commercial fishery; **outreach** - public interest, sexy topic, stewardship
A. Opportunistic (fisheries) Adults only	tagging through existing operations such as fishing industry	H	tags		
B. Targeted tagging adults	mark-recapture of marine mammals, photo ID	M-H	standard package plus tags, cameras		
c. Targeted tracking adults	track over time with tags and acoustic moorings	M-H	standard package and/or RAPT system for tracking, tags, cameras, ADCPS, time-lapse photography, aerial survey, digital ID tools		
D. Genomics (can be part of tagging and/or tracking)	collect tissue and analyze	M	standard plus genetic tools		
E. Otolith elemental fingerprinting	collect specimens through HI Arch. and analyze	L	fingerprinting tech		
F. Larval distribution patterns	collect and ID samples	H	plankton tows		
3. Specific geological features					
A. Survey	survey, map, groundtruthing, sampling, direct observations, ID and characterize organisms as well as features	H	standard package, genomic technologies, coring, molecular techniques; video live feeds for outreach, Hugo at Loihi volcano; dating technologies	standard partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS	**scientific** -history of HI, ID new species, species dispersal, evolution, biogeography, ID new habitats; **outreach** -public interest, lots of opportunity ; **industry** - fisheries, minerals, biotechnology
4. Extremophiles					
A. Targeted approach for ID purposes	known vents, trenches, seeps, cold water, fish guts	H	standard package, coring		
B. Characterize	ID through genomics and other molecular techniques	M	genomics, protein chemistry, GS/MS, need to develop better technology, bioreactors for culture purposes	drug companies, biotech industry, standard partners	**scientific** - new products, origin of life
5. Ecologically important habitats					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
A.Temporal/spacial observations	observations over time	M	Standard package plus, ADCP's	Standard partners plus outreach partners, fishermen, National Geographic, Discovery Channel	**Scientific** - biogeography, biodiversity, ecosystem interactions, community structure, management, restoration; **industry** - recreation, fisheries; **regulatory** - reserves, management
B. Funnel approach	mapping, then direct observations	H	Standard package plus	Same as above plus recreational divers	
C. Animal borne camera system	locating critical habitats with critter cam system	H	may need standard package, camera system	Same as above	
D. Targeted approach	use existing and historical information	H	may need standard package	Same as above plus recreational divers	
6. Active volcanism					
A. Access naval data		L	Standard package plus passive acoustic arrays, live feed for outreach	Standard partners, Navy, National Geographic, Discovery Channel, deep sea mining community, New Zealand, Japan, Island Nations, Indonesia, Australia, maritime industry, biotech, minerals	**scientific** - extremophiles, origin of life; **industry** - minerals, biotech; **outreach** - lots of public interest
B. Airborne geochemical	track plumes and trace elements from plumes from air, funnel approach	M-H	Standard package plus remote sensing		
C. Seismic		M	Same as above plus seismic technologies		
D. Passive acoustics	set up listening arrays	L	Same with acoustic tech.		
E. General mapping	locate features using mapping technology	M	mapping tech		
7. New species ID (macro and micro)					
A. Opportunistic	ID new species through existing expeditions	H	Standard package plus molecular and genomic techniques	Standard partners plus fishermen, Smithsonian, New Species Consortium, Sloan Foundation, National Geographic, Discovery Channel, Packard Foundation	**scientific** - origin of life, evolution, census of marine life; **industry** - biotech; outreach - can be a really big deal so huge public interest; **regulatory** - management
B. Targeted - geographic	going to areas and habitats that are not well documented	H			
C. Targeted - organisms	examining organisms for new organisms (parasites)	H			

Alaska Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Fjords of southeast and southcentral Alaska, especially the deep and dynamic ones (Hooge)	Contrast recent glaciated landscapes to more stable and tidewater to non estuaries. Tidewater glacial vs nonglacial.; Substrates for habitat mapping. Detection of species distributions. Determining some of physical and biological effects of deglacialization. They have complex oceanographic regimes and teasing out would be good.	Intense fisheries issues, MPAs establishment, emerging landscapes, often extremely dynamic. Lots of opportunities to leverage off of other studies in these areas. And lots of opportunities to have strong outreach component e.g. cruise ships. There are also recolonization issues e.g. following biocatastrophe; Isostatic uplifting.	Glacier Bay, Prince William Sound, Icy Bay.; Substrates for habitat mapping.	Multibeam, groundtruthing including submersibles, ROVs, AUVs, and oceanographic sampling with CTDs, ADCPs; divers; ships of opportunity	1
Documenting climate variability (Molnia)	500 million year record of global climate. Need to examine it to look for variability	Is human activity changing the Gulf?			1
Glaciers (Molnia)	How did the glaciers existing in the Bering Sea change over time?	Not well understood	Gulf of Alaska continental shelf between Cook Inlet to Canadian Border	Sediment sampling, ROVs/Dives, high resolution geophysics	1
Explore environment created and released by retreating or advancing glaciers	sample; identify; characterize	fresh water inputs to ocean; consequences of rapid glacier retreat	southeast Alaska Glacier Bay	surveying bottom sediment; sampling	
Characterize / explore extreme environments	high salinity / low temp environments	identify new species and novel protection mechanisms against extreme conditions	Bering Basin / Arctic Ocean	extreme cold technology; sampling; biochemical genetic screening	
Aleutian Trench	Geology (improved mapping), corals, habitats, inventory, Methane seeps, trophic systems, new species	Possible feeding dynamics, possible resources in shallow areas, deep water coral communities for fish habitat, major subduction zone that is unexplored	From start to very end of Aleutian Chain	Mapping, multibeam ROV/AUVs, sediment sampling - coring; video	2
Aleutian Arc	structural arc; substrates; patterns of coral distribution; hydrothermal venting; Biodiversity, biology, and oceanography, volcanism	Geologically active, submarine volcanism; strong current habitats; migration issues	Region between the islands and north of the Arc. (abyssal plain); From southern boundaries of the platforms, north to abyssal plain of the Bering Sea	Sediment sampling, "everything", seafloor mapping, rock sampling, water column methane sniffing. AUVs for mapping broad shallow areas of continental shelf. Much better than using surface ship. MBARI has developed vibracoring system which could be adapted for this project.	2
Large Physical Features - Aleutian Canyons (Yogodzinski)	rate of the consumption of the physical plate; geochemistry; sediment transport; volcanism; biology of area; hot springs seeps; very interconnected physical systems.	important area that is poorly characterized; very systematic changes occurring along chain due to shape; Dynamic physical system; Integrated physical system and its connection to biology	Southeast Alaska, Aleutians; Deep Canyons in Aleutian Fore Arc (POC - Phillip Rigby and Gene Yogodzinksi); Bogoslov; near subvolcanoes	Multibeam, manned and unmanned submersibles (7000 m), technology that allows you to hold station in strong current.	2
How do breaks in the shelf edge (canyon) influence the distribution and abundance of species; are they the locale of novel species assemblages	survey and sample a suite of canyons	may be important areas for production of fish or advection of deep-dwelling species onto the shelf	canyons in Gulf of Alaska, Aleutians, Bering Sea	trawls; nets; sampling; visualization techniques; physical oceanography tools	
Bering Sea Canyon	Geology (improved mapping), corals, habitats, inventory, Methane seeps, trophic systems, new species	Is human activity changing the Gulf?; Interaction with shallow water	Bering Sea Canyon; Kodiak Seamount	Mapping, multibeam ROV/AUVs, sediment sampling - coring; video	3
Continental Rise and the Outer Continental Shelf, right down to the Abyssal Floor Plain	Biological communities, geologic history, record of continental climate	Least studied part of the ocean, a place where the bigger tsunamis may be generated from slope edge slumps,	arc of the Gulf; Gulf of Alaska continental margin, Bering Sea, e.g. at the base of the margin cutting the canyons,	Suite of geological and biological sampling devices; underwater positioning	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Information Need/Gap	What	Why	Where	Technologies	Interest
Hydrographic, bathymetric and tidal data - mean low and high water (Baird)		Not mapped; not enough resolution in existing maps; Tidal data to establish boundaries; how sea data changes with events	Western and northern Alaska; Bristol Bay, Arctic Basin, Bering Sea, Bering Strait, Bering Sea (data gaps areas)	Side scan, tide gauges; Backscatter processing, mapping	4
Bering Sea Fish Habitats (McConnaughey)	Bathymetry - sediments, habitat; hydrography; tidal data; biology (temporal)	Lack basic information; Areas will not be looked at by other organizations; high variability habitat; Very important spatial gaps; Temporal gaps; e.g. near shore, Bristol Bay was home of most valued single species in world at one time. Oil and gas interest in the area. Truly unknown undescribed areas.; high value commercial species	gaps in data of Bering Sea - Bristol Bay	What is relevant scale?; Issues: uncoordinated, overlapping mandates. Classified data and getting access to it; Ships of opportunity as technology. Interfarometry.; multibeam; sidescan; backscatter	4
Catalogue the distribution and abundance of the types of species that are in the mesopelagic zone, benthic habitats that support important ecosystem components including fish and rare or special species and essential fish habitats	what is the importance of these features for maintaining biodiversity; cataloging; features; mapping	MPAs; fishery restrictions; critical ecosystem; resources; critical resource of high trophic level organisms (big fish, birds, mammals)	continental shelf; Gulf of Alaska; Bering Sea; Chukchi Sea; shelf edge and basin of Gulf of Alaska	bottom profiling technologies; optics; satellites; nets; tagging; underwater visual technology; PSATS	
Gain knowledge and understanding impacts of essential fish habitats; candidate areas of protection	benthic habitats; mapping; photography; inventory	role in supporting ecosystem spawning	Pribiloff Canyons; between Aleutians and shelf break		
Seasonal exploration	Biological, geological, cryosphere, biological and physical oceanography,	Completely unknown and potentially very biotically important	Continental Shelf spawning area, Bering Sea (Bristol Bay, northern Bering Sea e.g. along the ice edge, central Arctic Basin, whole ice edge), Cook Inlet (issue - other organizations working on it).	Icebreakers, submersibles, remote sensing, full blown submarines, multibeam	5
Sea Ice in Bering, Chukchi and Beaufort Seas (Pawlowski)	Biology and physical processes going on. Ballena studies. Increased fetch. Change in migration patterns.	Change in ice distribution. Climate response issue. ; Major rookeries for pinnipeds and seabirds. Bering Sea is in an ecosystem crises.	Nearshore reefs e.g. Camden Bay. Along Arctic barrier islands. Some of the Bering Sea Islands for coastal erosion.	Remote sensing whether airborne or other. Mapping tools. On vessels of opportunity.	5
What is the role of sea ice cover in structuring the marine ecosystem; how does this vary with latitude of the edge; how does the ice cover link the Arctic to the Bering Sea	what organisms are present and how they vary between regions?; ice characteristics (thickness, structure, etc.); exchange with water column	sea ice is believed to play a critical role for production of shelf ecosystems; predicted to diminish; cultural asset	Chukchi Sea; Bering Sea	ice-going vessel; remote sensing - satellite; ice moorings; autonomous platforms	
Plate Boundary - Strike Slip System	mapping, water column survey, id and characterize; Taxonomy	Neotectonics, seeps, compare w/ other plate boundaries. Large earthquakes, sediment slides. Not well documented; Possible coldwater petroleum seeps	icy strait - Canadian border to Alsek River. South of Icy Strait. Fairweather Fault; Yakatat Terrain	Cameras, ROVs, AUVs, ADCP, multibeam	6
Intertidal Zones	Biodiversity, taxonomy, ID and characterize. Archaeology.	Not documented. Remote nature, add value to other studies.	Aleutian Islands, Islands in Gulf of Alaska e.g. Shumagins, Kodiak Island Group; Alaskan Peninsula	Via helos from ships, Alaska Peninsula, standard biological sampling, LIDAR,	7
Acoustic Monitoring	seismic acoustics; fauna acoustics; Marine mammals, fish, migration paths	New way to look at ocean, learn a variety of things	Aleutians, SE Alaska, Aleutian Arc, Bering Sea,	Hydrophones, observing system(s),	8

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Information Need/Gap	What	Why	Where	Technologies	Interest
Submarine Seamounts	Evolution of seamounts. Circulation and currents.; ecosystems; deep water	Unique ecosystems, centers of upwelling, unique species, unique trophic systems, food webs	Southcentral Gulf of Alaska (Gulf of Alaska Seamount Province) e.g. Pratt-Welker Chain, Patton Murray Chain, South of the trench (e.g. Adak Island, Central Aleutians, Atka Island).	ROVs, submersibles, new technology (e.g. video to speed up processing) Issue - need automated processing of video data. High definition video. mutilbeam.	9
Traditional Knowledge	Western science vs native observations, compare life histories of animals	The value of the data sets, extend the time series	Hada Villages in SE, Traditional grounds of Hoonah Village, Tlingit village, St. Lawrence, Northern Bering Island	Interviews, archaeological tools, biological sampling, multibeam, LIDAR, side-scan sampling	10
Circulation Survey	subsurface current	Benthic organisms, distribution of nutrients	Western Alaska, Nome, Bering Sea, Chukchi Sea	ADCP, moorings, remote sensings,	11
WWII and Later Human Sites	Location and characterization of site, artifacts ; Effects on ecosystems and food chain	Environmental impacts, history, need for potential cleanups; protect sites	Western Aleutian Islands, Kiska Island, Duke Island (SE AK), Attu Island,	Diving, side-scan, multibeam, archive searching	12
Pre WWII (Gold Rush ships)	Location and characterization of site, artifacts ; Effects on ecosystems and food chain	history, protect sites	SE Alaska, Lynn Canal	Diving, side-scan, multibeam, archive searching	12
Location and understanding hazard dumps; characterization	determine location; chemistry of material	potential biohazard	Aleutians	hazard sampling techniques; underwater moorings	
Continental Margin (shelf and slope) of the Beaufort Sea	Bathymetry, navigation hazards, biota	Arctic path for shipping. Unknown biota	North of Sag River, entire shoreline of Beaufort Sea, Cape Lisbourne	Partnering w/ others, single channel sidescan, multibeam, fathometers in shallow water, LIDAR,	13
Archaeological Information on Human Migration	Sites of ancient villages, possible migration routes, ice records,	To determine if that was the major migration route for humans	Fairweather Ground	Multibeam, ROVs, very high resolution side-scan "pseudo sidescan" (backscatter),	14
Gas Hydrates	Interaction w/ ocean. ID and characterize communities associated with them. Distribution and location.	Two orders or more of Methane (is it recoverable?), more methane than other fossil fuels,	Deep Gulf of Alaska, Beaufort, North Slope, Chukchi, Wrangall Island.	Seismic profiling, sniffers, gas profiling, sidescan	15
Identify and catalogue the trophic webs that support birds and mammals in the wintertime; look at what physical processes impact their system	what zooplankton are available for species dependent on their food type; water column biology (zooplankton); ocean physics; sampling	many birds and mammals spend winter in Bering and Aleutians, but know little about what they eat there; supports endangered species; food web dynamics info	South Bering Sea; Aleutian Islands (wintertime)	biophysical moorings (winter); new sampling technologies under high sea states	
What are the abundant and important microbes and micro-zooplankton of the Bering and Chukchi Sea; Gain knowledge of ecosystem health; long-term variability	microbiology and micro-zooplankton sampling	these organisms likely play critical role in function of ecosystem	Chukchi Sea; Bering Sea	specialized sampling and growth chambers; microscopy	
Information on microscopic interfaces of chemistry, microbiology (liquid-solid interface)	explore unknown micro- / nano-environment; characterize it	lack of understanding; changes affecting ecosystems and ocean productivity; role in producing biocompounds and enhancing biodiversity	shelf, shallow water	microsampling; micro- and nano-technologies	
Where do high latitude organisms go to spend winter	support for designation of critical habitats	vulnerability of birds, mammals	Polynyas - St. Lawrence, Sereniki, St. Matthew	biological and physical tools; benthic sampling	
Need data and information on large-scale circulation and variability of Beaufort Gyre	explore largest freshwater reservoir	one of largest fresh water reservoir capable of influencing global climate; accessibility problem	Beaufort Sea / Arctic Ocean	remote sensing; autonomous platforms; ice-going vessels, moorings	

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Emphasis Area: Bering Sea, Aleutian Arc & Trench, Gulf of Alaska (including seamounts, fjords, continental margin), Iced Areas

"Standard" Partners - NOAA (OMAO, NESDIS, NOS, Coast Survey), NURP, NMFS, AFCE, NOPP, U of Alaska, Oregon State Univ, UNOLS Community, Alaska Native Science Communities, MMS, USGS, Prince William Sound Science Center, North Pacific Research Board, US Fish & Wildlife

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Bering Sea					
1 - funnel	characterize sea beds;	high		USGS; commercial; NMFS	salmon disaster; fisheries issues
Bristol Bay; open water	bio and physical systems; surveys; currents; sediment transport; groundtruthing		standard package; multibeam; LIDAR of seabed; multibeam; imaging; video		global ecosystem (high priority of Bristol Bay)
2 - observation	collecting tidal info.; sampling; groundtruthing	high	standard package; high resolution; research trawls; HDTV; moorings; sampling;	standard partners; fishing industry	characterize undiscovered areas; essential fish habitats
Bristol Bay			grabs/corers; seasonal moorings		
3 - funnel		high	ROV; seafloor surveys; current meters	standard partners; bilateral explorers	undiscovered; understanding hazards; undisturbed habitats;
canyons	surveys; sediment transport; biological, physical oceanography; climate history; benthic biology; cold seep environment				productivity of Bering Sea; bilateral exploration
Aleutian Arc & Trench				USGS, AVO	undiscovered areas
1 - funnel					
trench transect	surveys of structures on Pacific Plate; deep trench; seep communities; biology; slumps (sub landslides)	high (though depth limit)	deep vehicle capabilities; high pressure samplers; deep tow; rock dredging	JAMSTEC	characterize dynamic environment and connecting to biological communities;
canyons	sediment transport; bedrock geology; benthic biology; thermal venting; physical oceanography;	high (though strong current problems)	station keeping for ship & vehicle		unique area; gateway thru Bering and Pacific; understanding earthquake and tsunami hazards;
Aleutian Ridge; shallow water	thermal vents; structures; chemistry of hydrothermal system; vulcanology	high	vent samplers; acoustic monitoring		undisturbed ecosystems
environment of passes (central and western Aleutians; Adak to Kiska?)	benthic and physical oceanography	mod (strong current problems, tidal range)	CODAR (new tool)		
Aleutian Back Arc	thermal vents; structures; chemistry of hydrothermal system; vulcanology	high	acoustic monitoring	US/Russia	
Iced Areas		lots of challenges - darkness, extreme temps, ice, storms			
1 - wintertime exploration	Bering and Chukchi				
biology	survey migration of seabirds & mammals	low	wildlife tags; remote sensing - satellite;	industry; Navy; US/Canadian/Russian Coast Guard;	economic significance of fisheries;
distribution & abundance of biota			AUVs; ice breaker ships	Native Communities;	migration behaviors knowledge of marine mammals;
ecology of mammals and fish					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
2 - survey of bottom & circulation of perennially covered ice areas	deep water	low	aircraft for cold weather	NSF, Arctic Logistics; BASC (Barrow Arctic Sci Consort); VECO Corp.	understanding climate variability;
3 - observation	spatial and temporal observation	mod	acoustic monitoring, National Technical Means; thermal imaging		filling gaps in knowledge
Gulf of Alaska					threatened species, sources of mortality
1 - fjords (targeted surveys)	deep water; high current areas; ice face; rapid deglacierized areas; archaeology	high - deep water, rapid deglacierized areas; mod - high current areas & ice face	ROVs; AUVs; HDTV; remote sensing - satellite (ASTER, LANDSAT 7)	cruise lines	fisheries; MPA issues; tourism - public interest
2 - outermost continental margin (targeted)	outer shelf slope valleys; high resolution surveys; abyssal plains; physical oceanography; hazmat dumping; climate history; biological communities; cold seep environment; gas hydrates	high	multibeam; deep tows; gas hydrates - seismic reflection, sidescan/backscatter, water column surveys	various commercial companies; Navy	undiscovered areas; characterizing unique environments; understanding submarine landslides / instability
3 - strike slip plate boundary	locating cold seeps; natural hazards; cold water petroleum seeps; neotechtonics	high	ROVs; basic surveying tools; standard package	Canadian Gov't (Earth Science Sector); Petroleum Corps	natural hazards; unique nature (chemical nature and corresponding biology)
4 - seamounts (targeted surveys)	benthic and pelagic biology; biological hot zones; history of seamount; physical oceanography (currents change); undisturbed sediment accumulation on summits; upwelling zones	high	ROVs; ADCP; detailed mapping & sampling; trawling gear (700m)	Navy; MBARI	ecology of undisturbed ecosystem, fisheries; refuges/isolation
Archaeology					
1 - Gulf of Alaska (Cape Spencer to Cape Suckling - west of Juneau to SE P.W. Sound) - funnel;	broad survey; high resolution survey	high - location; low - recovery	multibeam side scan; ROVs; human diving; special equipment for artifacts - lab facilities for preservation & stabilization	museums; salvage org, MMS	history; human interests
2 - inland water S.E.; Aleutians; Bering Coast;	WWII; gold rush; whaling	high - location; low - recovery	multibeam side scan; ROVs; human diving; special equipment for artifacts - lab facilities for preservation & stabilization	museums; salvage org, MMS	history; human interests

West Coast Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interest
Knowledge of the deep sea water column (largest biomass on planet)	biota - what organisms exist (distribution, abundance, dynamics)	unknown, undiscovered, unexplored; evolutionary relationships; size and volume of habitat; unknown result of human impact; linkage of slope and shallow water; trophic linkage between protected and other species; carbon flux; linked to inorganic processes; link to climate change	bottom mixed layer to sea floor; deep water North Pacific on coast	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; genomics on a chip	21
Biological oasis hot spots	discover, inventory biota; explore; identify processes; find new areas	discover; biodiversity	seamounts, canyons, upwelling; ocean frontal zones; river plumes; seafloor hydrothermal vents	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomics on a chip; generation of sampling technology (give 100x more data) ; genetic markers on AUVs; remote sensing technology on AUV; real time capability; chemical sensor; PSATS; electronic tags; acoustics; acoustic mapping; ROVs; sampling systems; video; sub; long-range AUVs; sensors for gas analysis; higher resolution chemical sensors; long-term instruments that can survive in the canyon environments; temporal exploration; physical ocean modeling; genetic probes; insitu visualization; observation techniques; fiber optic observatory	16 16
Habitat on nearshore (shelf and slope); Archaeological paleoclimate area	understanding of flows of chemicals; fisheries; understanding biological hot spots; sediment transport; physical, current flow interactions; discover history influences; understanding margin marine boundary layer	intensive human impact; link of chemistry and biota	0-1000m depth; 0-100m transport	generation of sampling technology (give 100x more data); genetic markers on AUVs; remote sensing technology on AUV, etc; real time capability; chemical sensor	15
Plate scale to mesoscale observatory; long-term understanding of episodic events	absorption of CO2; long-term; needs thorough mapping effort; collaborative effort; new ways to do oceanography; understanding fluid flux productivity of subduction zones; sources of interplanetary life	Scientific CNN; opens temporal domain; resolves limitations of surface vessels; interactive telescope into inner space	observe 50-70km	fiber optic observatory	13
Canyon systems, gulleys (physical, chemical, biology systems)	turbidity currents; internal waves; bridge from shelf to deep sea; develop proxies of variability over time in sediments	cable routes; essential fish habitats; biohazard dumping; grocery run for deep sea organisms	west coast; Big Sur Canyon Complex	long-term instruments that can survive in the canyon environments; temporal exploration; physical ocean modeling	11
Productivity of ocean in euphotic zone	discover new members; <20 microns (includes viruses, parasites); spatial structures (scales); need balance equation	HABs	euphotic zone; Central Gyre; Monterey Bay	genetic probes; *insitu* visualization; observation techniques	10
Knowledge of the deep sea floor	biosphere at seafloor; benthic community; crust & microbial communities; i.e. all deep sea floor communities	earth's history; proxies to understand sediment records; simultaneous process documentation over a decade opens the door to millennium; crustal processes compared to other planes; link to climate change	bottom mixed layer to sea floor; deep water North Pacific on coast	imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomics on a chip	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need/Gap	What	Why	Where	Technologies	Interest
Pelagic animal movement and orientation	how the populations succeed; behavior patterns; interactions with ocean structures; use of habitat; range and navigation	discovery and explore; unknown human impacts; stewardship; ambassadors of ocean life; physiological adaptations to understand and to add to biomedical knowledge	Basin scale Pacific Ocean; eastern North Pacific Ocean; entire water column	PSATS; electronic tags; acoustics; imaging	9
Hydrates, fluids (seawater and gases); Crustal processes that affect fluid flow	determination of location and volume of hydrate resources; classification; chemistry; fluid flow; subduction zone; hydrothermal processes; microbial populations and dynamics; fluid pressure and quantification of flow	energy source; impact on environment (climate, carbon cycle); geohazard/sea floor stability; means by which earth cools itself; how fluids are forced from crust	300m-3km (maybe more) depths; emphasize below 1000m; EEZ; outcroppings; plate scale; active seeps; middle of plates	acoustic mapping; ROVs; sampling systems; video; sub; long-range AUVs; sensors for gas analysis; sensors for gas analysis; higher resolution chemical sensors	6
How to configure exploration when we don't know form of pay off; what will optimize discovery; issue is larger than NOAA; how to optimize rate of discovery					

Crosscutting Ideas

champion full utilization of underwater arrays

fuller utilization of classifies technologies

explore ways in which oceanography can be done - cooperate across groups (interagency)

Comments

rare species definition and few in number

animation of data for science and education

production of quantitative maps, real time maps

data management: archival, servicing to public, presorting, relating databases, standard methods for management, cannot be too far removed from scientists

20% of total effort

how quickly data is available - measure of success; how much data is coming out

handling of data sets

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
"standard" package - definition from common approach terms plus dynamic positioning & bottom high resolution survey capability (not always needed for ops, ROV), sensors dependent upon expertise with mission, high quality communications & internet	"potential" partners - educational outreach group, university (UNOLS), NMS, Navy, NOAA, NASA, NSF, Alliance for Coastal Tech (NOAA), USGS, USCG, NGOs

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Knowledge of the deep sea water column (largest biomass on planet)					
1 - simultaneous surveys (AUVs), precision with ROVs	surveys via AUVs; sweeping water column; detailed survey then expand	high; labor intensive for water column	image recognition and software; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities	potential	know how ocean works; discovery is guaranteed
Biological oasis hot spots					
1 - targeted (but focused and surveys simultaneously)	close in seamounts then remote seamounts; survey triage of hot spots; different tactics for each hot spot	varies by hot spot	<20 microns technology very important; real time capabilities; anecdotal fisherman reports; tagging (PSATS); "Ready 5" capability	fishing industry (Russians, etc.); MMS	commercial fisheries; potential conservation areas; biogenetics
Habitat on nearshore (shelf and slope); Archaeological paleoclimate area					
1 - targeted	targeted anthropogenic impacts; high definition visual surveys; look for arch. sites of previous civilization; look for deeper wrecks	high (but can vary by hot spot)	sidescan; magnetometers; sub-bottom profiling; laser line scan; range gating system; geochemical measuring systems; geology system (porosity); sediment transport system (suspension)	cultural resource organizations; Navy (NAVO); oil companies; museums; NGOs; National Cultural Archival Org; States Historical Preservation; tribes/islanders; ecotourism	understand part of ocean directly most interact with & human impact; reach new stakeholders; connection to public; conservation areas
Plate scale to mesoscale observatory; long-term understanding of episodic events	small scale perturbative experiments				
1 - funnel; targeted; real time	gyre scale	observatory - may not be low feasibility. Only listed that way due to costs over the long term.	large logistics; huge communications requirements	telecommunication industry; oil/gas industry; Canada, Germany, etc.	internationally unique; new paradigm of sampling in time and space
Canyon systems, gulleys (physical, chemical, biology systems)					
1 - targeted; observation	hyperpicnal flows; observing systems for long term; investigate submarine rock flows	mod (difficult to catch events)	forward scatter acoustic techniques; equipment survivability cabling systems; need hardened sensors; "instrumented rock"	cable companies; USACE; CSO	understand how major component of the ocean works; history/origin of canyons
Productivity of ocean in euphotic zone	understanding life stages of organisms				

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Emphasis Area: Ocean Dynamics and Interactions					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
1 - funnel; survey		high	new genetic methods; new techniques for energy flow thru life form systems; genetic probes; active fluorescence	Russia, Poland; agriculture companies; commercial fisheries; remote sensing (NASA)	understanding health of oceans
Knowledge of the deep sea floor					
1 - simultaneous surveys (AUVs), precision with ROVs	surveys via AUVs; sweeping water column; detailed survey then expand	high; labor intensive	image recognition and software; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities; navigation	potential	know how ocean works; discovery is guaranteed
Pelagic animal movement and orientation	how animals find guideposts in the open ocean; animals as ocean explorers	large animals - high; medium animals - mod; smal animals - developing	PSATS, archival tags, acoustic network tracking; active acoustic tracking; ARGOS; imaging systems	university; electronics industry; Census of Marine Life; fishermen (recreational & commercial); conservation groups	establish biological hotspots in ocean; identify common mechanisms of movement; conservation and protection of important species

Comments:
need more tech capable organization and facilities

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
Continental Shelf	general baseline mapping (high resolution), habitat substrate, geo/bio/chem, current, temperature, ID and characterize	Need good habitat mapping, documenting relationships between bio and surrounding habitat. Near shore is important commercially and recreationally. Need to identify impacts to these areas.	West Coast, existing protected areas, proposed MPAs, cable routes, heavily trawled areas, areas of heavy coastal/urban development. Same locations as above. Also untouched areas.	Standard regular remote sampling techniques, temporal/seasonal sampling tools. Higher resolution remote sampling; processing/visualization tools	1
Midwater	Species diversity; ID and characterize; food web; link between upper water and benthic water; how the midwater functions in this role; evolutionary relationships; geographic relationships; connectivity	Not much known, relation with upper water community	Gross global sampling (have some info on Japan and Monterey Bay)	Genetic tools; ROVs for filming, sampling and observing behavior; HDTV video very useful; establishing strobe frame photography at some time series sites to get understanding of change of abundance	2
Banks	mapping, subsurface information, sub bottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Cordell Banks, Tanner/Cortez Bank, Oregon Bank complex, Southern California Border Banks	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Sea Mounts	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Davidson, Guide, and Pioneer Seamounts, and Gumdrup and Taney Seamounts; Brown Bear and Cobb Seamounts; Bowie Seamount Chain.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Canyons	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Canyons: Big Sur Canyon Complex, Pt Conception complex; Juan de Fuca; Rogue Canyon, Eel River Canyon; Quinalt Canyon; Santa Cruz Canyon; So American canyons (re: strike slip transition).	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Fracture Zones	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	Mendocino, Molokai.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Emphasis Area: Observation and Mapping					
Information Need/Gap	What	Why	Where	Technologies	Interest
Subduction Zones	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation		Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	3
Deepwater corals	Locate, map, characterize and ID; Assessment of threats - existing and emerging. Other species supported by habitat.	Extremely cool, very old, contain excellent deep sea climate records (deep sea climate gradients), loaded with bioactive chemicals, biomedical applications, very diverse and economically important, at dire risk of elimination.	Rocky bottom areas; low sedimentation rates, high currents - below trawl depth. 1-2 KM priority. Monterey Canyon, Astoria Canyon Flanks of seamounts (see above).	Deep camera tows, further development of laser technology, lowlight cameras in rough terrain, slow moving steady AUVs	3
Ships (shipwreck) of importance.	mapping habitat, multidisciplinary effort, chemo/bio/geo	Environmental impact, maritime history, exciting topic, legal/regulatory mandates	Workshop results and historical records. Determine location. Luckenbach (San Francisco), Montebello (off Cambria) possible tar issue, Pack Baronesc (entrance of Santa Barbara Channel) bulk cargo of copper sulfate.	Mapping technology, chemical analysis, shipwreck integrity tools	4
Marine Archaeology/ Human Habitat	Develop strategy on where to look, location, photo documentation, controlled removal, habitat, climate	Would answer major questions about inhabitants of west coast of North America, would answer timing questions, Heritage Data	Develop strategy on where to look; Channel Islands, 140 m below sea level (old coastal level), Santa Barbara Channel, Baja California	Mapping of shorelines, light subbottom profiling, laser linescan technologies to direct sampling, coring technologies	4
Use of pelagic and benthic environments by economically/ecologically important species	Life history, migration patterns, habitat, population, distribution and abundance, environmental properties	Ecologically and economically important; exploited; need to know how they use their environment in order to get accurate assessment of them and to protect them if need be.		Basin wide, continental shelf, oceanic, existing protected areas, also see offshore productivity list, fronts and eddies	5
Use of pelagic and benthic environments by Rare Species	Life history, migration patterns, habitat, distribution and abundance, population, environmental properties	Little known about them, sense of urgency, they engender energy and excitement from public,	Same as above	Satellite tag, data storage tags, satellite remote sensing (benthic and passive), acoustics (passive and active), genetic tools, aircraft, human observation	6
Microinvertebrate assessments e.g. kelp forest assemblages and soft habitat; microbial ocean	Assemblages; Interactions; Predator/Prey Relationship	Huge educational advantages; Community structure and function; Form base of food assemblages; Unknown; New Species	California kelp forests, soft benthic habitats out to 60' (20-60' water depth)	Fiber optics, cameras, video, basic archaeological sampling, species identification	7
Microbial	Microbial assemblages, characterization, taxonomy, role they're playing in larger ecology; bio/geo/chemical processes; bioactive compounds	Biotechnology; human health; (e.g. blooms); cause-effect; pollutants (tracking)	Could go anywhere and make fundamental discoveries i.e. polar oceans, polluted and non polluted locations to compare microbial assemblages; Throughout water column including the substrate	In situ genetic sampling;	8
Seeps	mapping, subsurface information, subbottom profiling, biosampling, currents, temperature, chemical description, cores to sample the microbial activity	Untouched communities to understand equilibrium before disruption; trying to understand how they evolved thru time (e.g. transient?, duration of settlement in any one spot.) Unique species w/ biochemical properties; Assessing connectedness among and between; Genetic fingerprinting of some of the species; Effects of exploitation	between Heceta Bank and Hydrate Ridge; along alluvial (sp?) washout of Monterey Canyon.	Chemical sniffers, NMR, genetic fingerprinting, acoustic mapping, long term chemical sampling (e.g. osmosamplers)	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Emphasis Area: Observation and Mapping

Information Need/Gap	What	Why	Where	Technologies	Interest
High Temperature Hydrothermal Environments	Relatedness	Important for understanding origins of life on Earth	West coast of North and South America (fragments of the Farallon Plate) - interaction of a ridge with a continental margin), opportunity to look thru genetic mutations, how long ago were things isolated?	ROV sampling tools; physical oceanographic sensors; Larval sampling tools	9
Chemistry, Physics, Geology	Biogeographic cycling; inputs/outputs cycling	Residence times of certain molecules and chemicals; ID sources/sinks; understand effects of human introduced substances; better resource management;; better understanding of time based on signature left by processes; understand processes on other planets	Needs to be done in the context of the other Needs identified	In situ chemical sensors; satellite data; remote sensing;	Integrate
NOTE: Chemistry, Physics, Geology need should be integrated as part each need	NOTE: OE should analyze globally where seeps form (before shipping out)			NOTE: need new technology (and cost effective tools) for covering (to survey) large areas for energy sources and need technology that goes deep, especially unmanned technology - below photic zone.	
Technology Needs	Better data visualization tools; Registry of available data; Technology that supports adaptive (event driven) sampling				
NOTE: use part of 10% slated for education for visualization tool development. Info is only useful if it can be delivered.	NOTE: Ferret out traditional knowledge as way to discover what may have already been seen	NOTE: Reenact historical expeditions for educational purposes	NOTE: Reenact historical expeditions for educational purposes	NOTE: Jacques Cousteau Formula	
NOTE: more system examination of marine taxonomy through genetics	NOTE: Other data sets that can contribute to these needs				

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs	
Emphasis Area: Observation and Mapping	
Standard Package - add CTDs to original list	Standard Partners - NSF, NURP, ONMS, NMFS, Fish & Game, Oceanographic Institutions, Universities, Private Foundations, Museum/Aquaria, Sea Grant, Private Industry, Navy, USGS, NASA, MMS, Intl Partners, state geological survey, SHPO, Canadian counterparts, Mexican counterparts,

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Continental Shelf			Standard Package - ROV, Sub, multibeam, bioacoustics tech, ADCP, seismic profiling, remote sensing, observatory approach	Std Partners-states, sanctuaries, NOS, NOAA hydrographic program	**Scientific:** delineation of habitats, base mapping, basic understanding of benthos, substrate characterization **Industry:** mineral deposits, new resources, resource evaluation, biotech **Outreach:** "backyard", educational component (student & public), visualization benefits, involve public, entire community **Conservation:** sustainability, rational decision, biggest info gap
Funnel	Benthic				
Targeted	MPAs, proposed MPAs, cables, then go observe				
Productive Offshore Areas -					
Funnel	Survey-go down and explore	High	Std Package - larger vessels, backscatter data, observatory tech (observation approach), chemical sniffers, NMR, collecting tech, genetics, real-time processing, time-series revisits	STD Partners, no states,	Scientific: same as continental shelf, processes and interactions among organisms Industry: better resource planning Outreach: open new world, great discovery opportunities Conservation: planning, resource management, untouched environment, defacto protected areas
Targeted	Use existing data to make choices then survey and go down	High			
Observation	Time series observation (many instruments), time lapse camera to observe biota over time	Medium			
Partner w/ existing assets (opportunistic), Teaming	"piggyback" off existing assets and vessel	High			
Midwater Mobile Observation	AUVs/ROVs to remotely survey then sampling	High	STD Package - suction samplers, insulated compartment, observation & tracking technology, large samplers (new tech), collection tech, AUVs that follow, critters (new tech)	STD Partners - HBOI, Canadian ROPOS, MBARI, JAMSTEC (Japan), National Geographic Society, Discovery, MBA, aquaria	Scientific: important to carbon cycle, lots of species unknown to science, unknown contribution to food web Industry: app of new tech Outreach: topic of interest for general public, huge gee whiz factor, same as before Conservation: dumping regs
Moored Observation	Fixed position observation	Medium			
Tracking	Tag and Monitor, lifecycle	Medium			
Critter Cam	Place camera on critter	High			

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Marine Archaeology			High Res Imaging, Side-Scan, STD Package, Magnetometer, removal technology tools, laser imaging, saturation diving	Insurance industry, EPA, Coast Guard, ONMS, DOS, DOD, states, National Geographic, Discovery, Salvage Industry, (Ole Varmer - NOAA NOS Shipwreck Attorney)	Scientific: heritage insight, impact on environment & risk assessment, human occupation of NA Industry: salvage Outreach: tremendous potential Conservation: mandate to ID, protect and preserve
Targeted	Historical records/archives, traditional knowledge, pick sites, document & remove	High			
Funnel	Map (paleo shoreline), pick sites, doc & remove	Low			
Opportunistic	Look at mapping info from other missions then go to sites	Med-High			
Microbial Biology			Moorings, AUVs, sampling tools, smaller vessels, genomics, ROVs & HOVs, chemical analysis tools	Biomedical industry, EPA, Fish and Game, local and state health depts, Surfriders	Scientific: huge oppty for fundamental discovery, bioactive compounds, health in the coastal zone Industry: seafood, biotech, invasive species, human health, biotoxins Outreach: origin of life, challenge for outreach, conceptual more than visual Conservation: counteracting bioterrorism
In situ Sampling	In situ sampling and genomic identification & chem	High			
In situ Cytometry	Particle counter for small particles - size fractions	Med-High			
Bioluminescence	cameras - is there a good proportionality ratio that is pretty universal.	High			
Pelagic & Benthic	Ecologically/economically species		CODAR, STD Package, Tag tech Critter cam, acoustic processing tech, LIDAR	STD Partners, NPS, Military, biogeochemistry academic community, intl partners, Stanford Hopkins Marine Station, Census for Marine Life, MLML, Packard Foundation	Scientific: basic knowledge of behavior, migrations and how they use their environment, resource management Industry: sport fishing, small business Conservation: need to know more to protect them
Data Storage Tags	Track location of critter	High-Med			
Acoustic Tags	Beacon to uniquely ID individual	High			
Critter Cam	Attach critter cam	High			
Targeted	fronts/eddies - use remote sensing to ID areas	High			
Passive Acoustics	Listen and observe sounds	Medium			
Airborne Sensing	LIDAR to monitor, observe, track fish	Medium			
Natural Tags	Otolith-microstructure/microchem to ID their source/to track them/ageing	Med-High			

North Atlantic Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	**What**	**Why**	**Where**	**Technologies**	**Interest**
Understand Distribution & Functional Redundancy Between Communities of Organisms	stems, community ns	Not currently known, new biota, are there common rules governing these communities. To be able to develop first principals on how communities are constructed. In order to advise decision makers in areas where there is little data. Automatic education tool.	Canyons, slopes, cold seeps, seamounts, the abyss, fishing banks, oil seeps, hot vents, cold seeps, and on continental shelf - banks and basins. Canyons along NE and West Coast. NE Seamounts and West Coast seamounts; South America.	Standard set of methods - (see Technologies list above)	1
Areas of Abrupt Bottom Topography.	Abundance, diversity, community change, new species, turnover, refuge community, patterns	Tight coupling to water column, high flow, high productivity in benthic and epibenthic communities, fish communities, rapid community change in terms of abundance and diversity.	Seamounts (any seamount within our region e.g. Bear, Physalia, Mytilus, Picket); any offshore ledge , canyon heads e.g. Oceanographer, Hydrographer, Veatch, Norfolk, Baltimore; northern edge of Georges, in coastal zone where there is a steep channel among islands; gullies; ledges e.g. Gulf of Maine ledges, Stellwagen Bank, Jeffreys Ledge, Cashes Ledge	Refine the mapping, multibeam, AUVs in high flow situations, SCUBA, standard tools	1
Living Marine Resources	ID & characterize patterns	Commercial activities expanding into this region and we have little knowledge about these areas	Unexploited areas, unsurveyed areas, slope greater than 500 m, seamounts (see above), Mid-Atlantic Ridge	Standard technology	1
Exploring Species Interactions w/ Physical Environment	Physical, biological, ecological properties that govern these locations, patterns	Better understanding of communities for management purposes	Similar to "Understanding Distribution" need and "Areas of Abrupt Bottom Topo" need; also Fronts and gyres, and warm core rings	Standard Tools	1
Study Transitional Areas Between Biogeographic Areas & Shelf Slope Regions	Species distribution and ranges; species dynamics, tropic interaction, invasives, patterns	Very little information available that is not broad scaled; what regulates them?	Georges Bank, Cape Hatteras, 350m isobath, any biogeographic breaks	Standard Tools	1
Ecosystem Engineers and foundation species (corals, tile fish)	Abundance, location, diversity, new species, establish patterns	Ecologically important, management conservation issues, few species have effects on many	For corals: shelf break, canyons, edges of basins, seamounts, deep and inaccessible; For Mussels: Grand Manan Basin, upper slope environment	Standard plus time series observations	1
Bioprospecting	Biotech industry	New products from the sea, human health, industrial processes, quality of life	Areas of high diversity, abrupt topo changes, deep within our region and tropical,	Bioprospecting technology, standard sampling technology that capture and keep specimen alive	1
Novel Feeding Relationships		Unknown and could be major sources of nutrition; discover new linkages	Coastal regions near algal beds, offshore basins, depositional environment, marine mammal hotspots	Sampling & stable isotope analyses for food pathways; remote sensors for marine mammals; Critter Cam	1
Shipwrecks (5-10K off New England)	Location, ID & characterize	We know little about historical technology; education and public relations, human history	Close to shore; fishing banks (Georges Banks, Jeffreys Ledge, Gulf of Maine, shipping lanes - close to shore, "right down the list"	Magnetometer, archival technologies, AUVs	2
Submerged Prehistoric Sites	Location, ID & characterize, which are still intact, paleogeography, paleo communities, paleo biological assemblages	Same as above	Shallower than 120m isobaths, near major drainages, coastal embayment, areas of intense fishing activity	Geologic mapping, coring, sub-bottom profiling, side-scan, magnetometer, AUV, Also local knowledge	2
Pelagic Realm - surface to deep sea	What's there? Species diversity issues, location, ID and characterize, function, what's there to exploit & conserve, patterns	Don't know what's there	Beyond shelf break e.g. Oceanographer Canyon and south	Submersibles, ROVs, acoustics, sampling tools to collect gelatinous organisms	3
Observing Episodic Events & Rare Species e.g. storm, blooms	Short-term events - frequency, strength, intensity, impact, magnitude, compare & contrast	Non commercial activity, not done, understand processes, synergy	MPAs, abrupt bottom topography, areas representative of a range of topographies e.g. ledge vs. flat bottom; e.g. Gulf of Maine, marine mammal habitat,	Camera, observation technology	4
Observing Rare Species	For fish & marine mammals: migratory & threatened species e.g. location of bottleneck dolphins, unusual spawning, general behavior	Fish community diversity, species extinction, sentinels of change, invasion, insight into species dispersal,	MPAs, fish aggregation areas e.g. Stellwagen Bank, ledges, fishing grounds, plane used by marine animals	Cameras, observation technology	4
Non Biological Resources (note: this should not be the focus of OE)	Minerals, oil & gas, hydrates, location, occurrence, stability, mixed aggregate	Valuable resources, data sharing, (sources of info)	U.S. EEZ	Archive data	5

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Information Need/Gap	What	Why	Where	Technologies	Interest
Seamounts	Systematic documentation	Not well documented	All seamounts e.g. New England seamount chain	Standard	6
Submarine Canyons	Not well documented	Not well documented	All major canyons e.g. Georges Bank canyons and mid-Atlantic canyons e.g. Oceanographer, Veatch, Baltimore, Norfolk, and Wilmington Canyons; Pueblo village communities and the canyon axis, boulder fields, slip stone outcrops	Standard	6
Ledges	Not well documented	Not well documented	Jeffries Ledge, southern Cashes Ledge, Fippennies, Platts, all along the coast of Maine e.g. smaller coastal ledges	Standard	6
Banks	Not well documented	Not well documented	Stellwagen & Georges Bank, Nantucket Shoals, Tillies & Browns Banks, Banquero & Emerald Banks	Standard	6
Basins	Not well documented	Not well documented	East & west Tillies Basin, Georges, Jordan, Wilkinson & Stellwagen Basins	Standard	6
Abyssal Plain	Not well documented	Not well documented	South of Oceanographer & east of Norfolk Canyon	Standard	6
Slopes (600 to 4000 ft)	As above	As above	Slopes adjacent to ID canyons or seamounts	Std	6
Gravel Windows - sediment disturbed & gravel exposed	As above	As above	Stellwagen Basin	Std	6
Protected Paleo Shorelines	As above	As above	South of Long Island & Nantucket; Gulf of Maine, Weymouth	Std	6
Gravel Cobble Bottom - continuous features vs discrete	As above	As above	Corsair, Oceanographer, & Hydrographer Canyons, Stellwagen & Georges Bank, Great South Channel, Jeffreys Ledge	Std	6
Channels	As above	As above	Great South Channel, Northern Channel	Std	6
Glacial Scoured Areas	As above	As above	Northeast Stellwagen Bank, Jordan Basin	Std	6
Shipwreck Aggregation Sites	As above	As above	Nantucket Shoals, Hatteras, Graveyard of Atlantic, Stellwagen Bank, Boston Harbor entrance, Long Island Sound, Buzzards Bay, Narragansett Bay, entrance to Chesapeake Bay, outer Cape Cod, Casco Bay, & New York Harbor	Std	6

Issue: How do we get access to existing data specifically for submerged archaeological sites! John Fish, American Underwater Search and Survey, most extensive submerged arch site data. Need to work with them e.g. data coordinator to look across exploration data to see how it would be useful to others.

Issue: when do you not let the public know about submerged archaeological sites?
Issue: Use charts to ID blank areas that have been unexplored.
Issues: Seafloor topography - mapping should be derivative of exploration rather than the focus; work with other NOAA offices; multi-beam area for multiple exploration efforts
Issue: Storing of data
Issue: Resource mapping should be in public domain
Notes: #6 should be discussed in the context of these other information needs.

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs	
Deep "Standard" Package (1): Class I/II Vessel with Acoustic Mapping; Dive Capability (ROV/AUV/Submersible) with Imagery/Video and Sampling Equipment; Precise Positioning System; Nav Mapping Tech; Coastal Standard Package (2): Class III/IV Vessel; Wet Diving Chamber/Compressor; DMT; Dive Master; Acoustic Mapping; Side Scan; Precise Positioning System; Nav Mapping Tech	"Standard" Partners

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Risk	Enabling Technologies	Partners / Available Assets	Key Benefits
Ecological/Biological Group (1)					
Transect Approach	Large Group Set Sampling Standards (includes ability to document serendipitous), look in new places, choose sites based on biogeo (lat & between oceans), survey along mega transects, multi-beam maps, sampling all along transect	Low	Coastal & deep packages, near real time satellite imagery, coring, suction sampling, digital still & digital/HD video, laser scaling, stereoscopic video, new applications of existing technologies, sidescan or sector scan sonar, dredge & trawl, laser line scan	Std partners, academia, NMFS, NURC, WHOI, DOI, Kokes, Navy, industry e.g. biotech	**Scientific:** pattern & distribution of tax & biological diversity; biogeography **Industry:** new resources, biotech products **Outreach:** mega big bang vs. targeted; web; circulation development **Regulatory:** new species; conservation targets; new MPAs
Targeted	Feature based approach; sample at selected sites	Low	Near real time satellite imagery		
Time Series Observations	Seasonal based observation transects, obs station taking temporal readings	Low	Obs tech that observe bio prop in addition to other ocean prop, cameras to monitor species, near real time satellite imagery, std oceanographic sensors, recruitment collectors, acoustics (passive & active), digital imagery, AUVs w/ sonar, ADCP		
Survey	Broad based remote sensing to select site; then same as others	Low	Satellites, Coastal & deep packages, near real time satellite imagery, coring, suction sampling, digital still & digital/HD video, laser scaling, stereoscopic video, new applications of existing technologies, sidescan or sector scan sonar, dredge & trawl, laser line scan		
Submerged Archaeological Sites (2)					
Funnel	Broad based surveying; choose sites; remote sensing, dive/ROV, sampling	Med	Coring; trenching; sampling tech; coastal std pkg or deep depending upon location; magnetometer; important to have; nav technology; sidescan and sector scan sonar, subbottom profilers, AUVs/ROVs, SCUBA/mixed gas, laser scan, digital mosaics, 3D imaging w/ sonar	Academia; Naval Historical Center; ONR; SHPO; Museums, ACOE; MMS; commercial survey companies (OSI & Alpine); ONMS; NURP; AUSS (John Fish); IFE; commercial contract archaeology companies; USGS; JASON Foundation; National Geographic Society	**Scientific:** location of significant sites; distribution models **Industry:** cleared areas for cables; pipelines; dredging; fishing; museum collections **Outreach:** significant public interest; educational possibilities **Regulatory:** federal/state agency mandates; MPAs
Targeted	Use existing knowledge including data mining (examine multibeam data), obs w/ remote sensing, dive/ROV, sampling; fishermen (hang sites)	Low			
Piggybacking	Tagging along w/ existing expeditions, same as above, impt to have archaeologists on board	Depends on location (possibly M)			
Pelagic Realm					

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Risk	Enabling Technologies	Partners / Available Assets	Key Benefits
Use all #1 approaches			Std Pkg, sampling gelatinous orgs, these tools on ocean platforms so they are full ocean accessible, sfc obs techs (indl night vision approaches), CTD, ADCP, profilers (water column-AVPPO), in-situ chem sensors	MBARI; HBOI (biolum)	Same as #1 **Scientific:** behavior patterns (critter) **Industry:** biotech **Outreach:** video of critter cam & gelatinous orgs **Regulatory:** MMPA, highly migratory species
Bioluminescence	Use biolum to determine distrib & abundance of different species	Low			
Critter Cam (small # of animals)	Use of camera on species	Med			
Tracking	Tracking organisms	Low	Acoustic telemetry, air interface tech		

Issues:
Count stars & compare groups

Infrastructure for data collection & distribution

#4 = Research

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Information Need/Gap	What	Why	Where	Technologies	Interest
Knowledge of Near Shore environments	Inventory, characterize Measure, habitats, bathymetry, Bio/Geo/Chem, Archeology	Most regulation oversight	Coastal New England	Shallow water mapping, Sediments, Remote Sensing, in Turbid water	13
Regional Archaeological Assessment; Cultural Resources, Chronology Site I.D.	Distribution of Wrecks; Structures; Aircraft, Items of cultural impact, Dump sites Identify all cultural resources with in a region.	Many sites are not identified; Environmental impacts; Human activity on the world; Chronology: Prehistoric, Historic, Current	Regional Assessment Sampling strategy needed (sites with a range of maritime landscapes; Regulation	High Resolution Survey - SUBs/ROVs /AUV's; magnetic Acoustic sensors	13
Knowledge of Gas Hydrates Provinces	Process of Gas Hydrates potential resources Effects of gases on chemosyntheic communities, Climate Impacts, Slope Quality	Impact on Global Climate; Impact on Habitats; Safety - Tsunami, bottom mounted cables	US EEZ; Hudson Canyon Region, (fiber Optic Hub)	Submersibles ROV's Sampling Methods	12
Need for increase expertise in Taxonomy of marine resources	National emphasis on taxonomy; Career field	Identify Interaction between Taxonomy	No specific regional focus	Technology can enable but its policy based - Human resources; presentation formats	12
Knowledge of impact of Seamounts on ocean dynamics; Also other abrupt topography	Ocean Currents, Ecosystems, Biogeography, Biodiversity	Impact on Fisheries health, Fundamental dynamics needed, role as biogeographic "stepping stones" Record of climate change in deep Corals	Bear Mount, New England Seamount chain; Mid Atlantic Ridge; Cashes Ledge; other small features	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	11
Character of Deep Water Archaeological sites	Wrecks; structures; cultural resources; Priority to older targets; local biota	Public Interest; Education; Historic Value; Regulation; Relationships to Habitats; Ecological Impacts;	Target identified by broader area of survey - Virginia Capes;	Deep water sub's ROV's / AUV's / Imagery & Video; remote manipulator; magnetic	9
Distribution of migration & abundance of Large, highly mobile biota	Marine Mammals; Giant Squid, Other Unknown species, Large Deep water Sharks;	Lack of Current knowledge, Public Interest, understand biodiversity & role in Ecosystem; Policy (International & Domestic)	Beyond Continental margin	Survey Technique; Tagging & Tracking; Acoustic Imaging, AUV's Imaging	9
Deep Pelagic Realm	Characterize, Biology Dynamics	Largest Ecosystem, Not sampled much	Sea Mount & Canyons Along the Continental shelf Greater 1000 meter & meso	Deep Submersibles, obs on a broader scale, AUV's; Acoustics Imaging, chem, Bio Sensor	7
Knowledge of Deep Benthic Community	Characterize, Biology, Geology, Bottom Interactions, Ecology Dynamics	Need to ascertain anthropogenic impacts; not well known,	Topographic feature of interest	Deep Submersibles, obs, AUV's; Acoustics Imaging, chem Sampling Techniques	7
Knowledge of existing sources of Baseline knowledge	Data Mining	Establishes level of baseline knowledge	All	Data Mining technology; Intelligent Agents	7
Knowledge of Submarine Canyons	Transport mechanism, Habitat Diversity, Sediment Transport; nutrient transport	Fisheries Impacts; Characterize Pollution Impacts, Impact on habitats Role of in Carbon cycling; Terrestrial impacts	Continental Margin; Hudson Canyon; Lydonia Canyon; Varied Geomorphology; Gradient of Human influence	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	6
Knowledge of physical & biological processes near fronts; Eddies, Warm and cold rings	Intersections between layers; Relationships to biota; Air-Sea Patterns / Interactions Impact of bottom boundary	Science Value; Impact on Fisheries; Lack of knowledge on Nutrient Sediments Transport; Impact on Cultural Resources & benthos	Gulf Stream; Labrador; Gulf of Maine; Long Island Sound	Remote Sensing; Fixed Sensors; Sensor Arrays; AUV's	5
Distribution migration & abundance of Gelatinous plankton	Pelagic Plankton, Vertical migration patterns	New Species Identification, It is the dominant Biomass; Fisheries Impact, Evolution Knowledge	Seamounts; Canyons; Along Shelf margin	Sampling Technology, AUV's	5
Knowledge of Deep and or Cold water Corals	Biodiversity, Distribution habitat	Fisheries Impacts; New species identification; Role in Ecosystems; Possible records of climate changes	Bear Seamount, Oceanographer Canyon, Lydonia Canyon, Nova Scotia & New Brunswick	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	4
Knowledge of Physical Processes related to geomorphology	Mass-gravity movement; Turbidity flows; Hydrate beds; slope instability; chemical analysis	Understand canyon formation processes, safety (geo-hazards) habitats, (*Partner with USGS)	US Continental Margin, Hudson Canyon region,	Sub/ROV/AUV Imagery, Seismic Survey; MCS; Acoustic Mapping	4

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	**What**	**Why**	**Where**	**Technologies**	**Interest**
Knowledge of impact of Fishing on Ocean Regions	Health of Benthic Habitat; Census of Marine Life; Archeological Impacts; History of technology;	Regulation; Public Interest; Impact on other Ecosystems; Fisheries Management; Lack of Info on Deep Benthic Fish; Discover the role in habitat information	Grand Banks, Georges Bank; Gulf of Maine; Area where fisheries are expanding into;	Sub/ ROV's/ AUV's Video Imagery, Sampling Systems; Acoustic Mapping	3
Chemosythenthic communities (subsurface - down several km): hydrate vents, seeps and vent communities	inventory and characterize, isolated ridge system, new biota, larger geographic context, physical & chemical systems	unknown regions, new biota, explore why communities exist, what turns these areas on and off? Significant communities through evolutionary genetics links between regions	Mid-Atlantic Ridge	multi-beam geophysical techniques, sampling techniques, satellite imaging, towed vehicles, subs, AUV's look at new technologies	2
Knowledge of micro-organisms in the deep sub-bottom	Sea floor Biosphere	Discover new life in sustaining process, biodiversity, science benefits, Exobiology interest, Origin of Life - Evolution Role	Deep water	Deep sampling technology; Ocean Drilling Program,	1

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Standard Package: Class I/II Vessel w/Acoustic Mapping; Dive Capability (ROV / AUV / Submersible) w/ Imagery / Video & Sampling Equipment (Not Only ROV / AUV / Sub); Multibeam; ADCP's; Precise Position System; Outreach Capability; Education Component	Standard Partners: Sea Grant; IFE; NMFS; NOS; NURP; UNOLS

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs			Enabling	Partners /	
Information Need - Approaches	Description	Feasibility	Technologies	Available Assets	Key Benefits
Knowledge of Near Shore Environments	Characterization			USA Core of Engineers	
Regional Archeological Assessments	Bio / Geo / Chem			State GOVT's; Academia; Aquariums; Not For Profit Entities; Science Education; USCG; Navy; Commerical	Science: Knowledge of nearshore environment Outreach: Large Public Interest & Impact
Physical / Biological shallow water processes Near Fronts					
Cold Corals					
1. Shallow Water - Small vessels	"Funnel" Approach	High	Archeological Application; Magnetic Sensors	Sea Grant Program	Regulatory: State & Local Governments; Recreational / Sport Fisheries; Commerical Fisheries
	"Funnel" Approach	Moderate	, Bottom mapping & tion capability; New otocols; Multi Line Multi Sensor Arrays	Aquariums (Maritime Aquarium @ Norwalk; Mystic, National Baltimore New England)	Regulatory: State & Local Governments; Recreational / Sport Fisheries; Commerical Fisheries; Education: Bio-Technolgies, Bio-Products
2. Autonomous Vehicles	"Funnel" Approach	Moderate	New sampling protocols; Multi Line Arrays and Multi Sensor Arrays	Maritime History Museums (Mystic Seaport)	Invasive Species; Cultural Resources; Resource Management
3. Aircraft	"Funnel" Approach	Low	- LIDAR(?)	Natural History Museums (Cape Cod)	
4. Field Sensors & Sensor Arrays	"Observation" Approach	Moderate	Chem / Bio / Geo Sensor Development	National Estuarine Research Reserve (Rachael Carson, Jacques Cousteau)	
				Smithsonian	
				Informal science education entities (Project O, Chesapeake Bay Foundation)	
Phys / Bio Process				States Aquariums; Educational Institutions; Non-Profits; Commercial Ventures	
Near Fronts Eddys					
Cold & Warm Rings					
Regional Archeological Assessments					
Deep Cold Corals			Data Mining, Conservation Technologies		
1. "Standard Package"	"Funnel" Approach	High	Magnetic Sensors; Sub-Bottom Profilers; Chemical Sensors; "Tailored" AUV Designed for Archeological Assessment		Regulatory: Conservation, Fisheries, Policy Development Outreach: Public Interest, Historical Perspective, Education, Science: Habitat Assessment, Biodiversity, Bio-Technologies, Bio-Products Industries: Commercialization, Tourism, Understanding of Distribution
2. Fixed Sensors, Sensor Arrays & Mobile Sensors	"Observation" Approach	Moderate			
3. Space-Base Remote Sensing	"Targeted" Approach	High / Low	Penetration into Deeper Water		
Knowledge of Gas Hydrate Provinces				Universities	Science: Habitat Assessment, Ecosystems; Climate Change Indicators

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Knowledge of Impact of Seamounts & Abrupt Topolography on Ocean Dynamics				Navy, Aquariums;	
Character of Deep Water Archeological Sites				Non-Profits; Museums	Industry: Potential Commercialization, Tourisms, Salvagers
Distribution of Large Highly Mobile Biota				States, DARPA, NSF, ASTO, DOE	
Submarine Canyons					Regulatory: Area Management, Species Protection Species, Salvage Policies
1. "Standard" Package	"Funnel" Approach	High	Non-Destructive Investigations, Robotic Manipulation; Sub-Bottom Profiling, Tools for Sample & Artifact Recovery, Interpretation Tools, Spectral Analysis Tools; Data Mining; Laser Line Scan, Critter Cams		Outreach: Education, Public Interest
2. Fixed Sensors, Sensor Arrays & Mobile Sensors	"Obseration" Approach	Moderate	Remote Tracking (Aircraft or Space-Based)		
Expertise in Taxonomy of Marine Resources	-Education		National & International Standards; Collections Management; Scholarship Programs	Educational Institutions: Sea Grant (?); Museums; Non-Profits	Critical to Establishing the Baseline of Existing Knowledge
	-Career Field		Training in Fieldwork for Applicable Disciplines		
	- Available Pool of Experts		Sponsoring Existing Entities with Expertise		
			Expert system can help enable		
			Graduate Fellowship Programs		
			Establish Positions (FTE's) for Populations by Existing Professionals		
			Service Academies		
			Establish Accommodating University Polices		
			Establish separate, Collaborative Institute		

Great Lakes Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
Life in one cubic meter of water	Seasonal change, species change, ID & characterize, transition rates, feeding rates, all of the rates	Ground truthing, comparison between different biota, symbiosis, sensor development (based on mother nature)	Contrast temperate vs. tropical, nearshore fresh vs. salt, contrast different parameters	AUVs, ROVs, subs, sampling, neutrally buoyant chemostats, low impact, low Reynolds #, new tech	1
Archaeological Survey & Documentation	Location; documentation, evolution of marine tech, 19th century, effects on bio (good time measurement), influence of currents, also look at known wreck sites	Largest density of shipwrecks & submerged cultural resources, need to be protected & managed	Throughout Great Lakes, deep water, Lake Michigan, Thunder Bay (already have resources) Lake Champlain, Lake Superior, Death's Door, ports, Keweenaw Peninsula	Interactive (w/ public) cameras, ROVs, multibeam, subbottom profilers, magnetometer, LIDAR, deep diving cold water diving	2
ID Prehistoric Submerged Archaeological Sites	Paleolake lines, ID sites, location, arch documentation	Earliest arch sites in region, better understanding of prehistoric life & tech	Nearshore Karst features, Straits of Mackinaw I, submerged river mouths, paleolake levels	Std, predictive modeling, side-scan sonar	2
Benthic Communities	ID & characterize interaction, effects of exotics, impact of fisheries, compare w/ oceans, food web	Failing in lower Great Lakes, need to understand why: Superior (untouched), fragile, have ignored benthic fishes in food web	Lake Superior, compare with Chesapeake Bay and Gulf of Maine	ROVs, Subs, sampling, AUVs	3
Abyssal Fish (> 50m)	Life history, impact of invasive species, spawning (where & how especially in winter season), character displacement behavior	Know very little, gene flow problem, recruitment problem, invasive species problems, displacement behavior	Upper Great Lakes, Superior, Huron, Michigan, eastern basin of Lake Erie	ROVs, AUVs, time lapse camera systems planted on bottom in strategic locations, Subs	3
Mesoscale Eddies – frequencies & importance	Current flow patterns, eddies, mixing process, impact on bio, frequency & importance to ecosystems productivity, Chem. props	Need to understand input on ecosystem; inference of global warming, correlation productivity, gene flow, recruitment, impact on benthic communities	Lake Superior, other Great Lakes, Yellowstone Lake	Current meters, satellites, ADCP moorings	4
Linking Climate Forcing to Lake Response	One effort across all lakes, temp, current, wind speed, barometric pressure, real time chemical composition	El Nino, global warming, understanding international variability, lake circulation questions, variation over lakes, better understanding of sediment record for paleoclimate, transport of toxics & nutrients, connection w/ boat people (outreach)	Ten largest lakes in the world, Lake Michigan (start where there are problems), need to be strategically position, Lake Champlain, Yellowstone Lake	Buoys, ADCPs, various sensors, mass spectrometer, wireless comms, real-time web access	4
High Resolution Spatial & Temporal Zooplankton Measurement	High resolution zooplankton measurement over space & time, classification	Major component of the food web depend on fresh water body	Compare Lake Superior and southern Lake Michigan, 10 largest lakes in the world, Yellowstone Lake	Bigger faster vessels (stationed in Lake Superior), optical plankton counter, towed vehicles, AUVs w/ zooplankton counter, in-situ genetic tech, video image classification tech	4
Carbon Cycling in Lakes	Carbon cycling, primary productivity, Carbon accumulation, Carbon consumption, compare among lakes	Test hypothesis of carbon cycling, each lake is a comparative experiment	Lake Superior, Lake Michigan vs. other lakes	Std, AUVs, primary prod techniques, sediment traps	5
Mapping	Mapping, multibeam	Foundation for exp, small portion of lake bottom mapped, insight into deep water circulation & sedimentation patterns	Lake Superior, Lake Michigan, all the lakes, Yellowstone Lake (done this year), Crater Lake, African Lakes	Acoustic mapping, magnetometer, subbottom profiler, ROVs/Subs	6
North/South Ridges in Lake Superior	Origin controversy, distribution of sediment & benthic communities, distribution of fish, influence of bottom currents	It's a major unknown in Lake Superior, lake is heterogeneous; ID these boundaries	Lake Superior (eastern half), northern Lake Michigan, eastern Lake Huron, Bering Sea	Mapping, ROVs, Subs, AUVs, sampling, moorings (ADCP)	6
Karst Features in Lake Huron (sinkholes)	Spatial coverage, depth, dimensions, biology, chemistry, local flow pattern	Potential source of groundwater input, fish habitat, prehistoric culture	Central Lake Huron	Standard, mass spectrometer	6
Ring Depressions (400-500 m across; 20-30 m deep)	How they formed, influence on distribution of benthic communities, sediments, contaminants, local flow patterns, why not in other lakes	Most widespread feature on floor of North America's largest lake	Lake Superior	Seismic reflection profiling, ROVs, sediment coring, subs	6
Artificial Reefs	Recruitment, deterioration of cultural material, environmental effect, new vs. used, lab	In fresh can do well controlled experiments	Artificial reef sites e.g. not too much fishing or commercial activity	Active acoustics, std, video, dive	7
Climate Change on Timescales of Decades to Millennium	How climate varies in space & time	Relevance to societal needs (e.g. global warming to inter annual trend prediction), higher resolution than ocean cores	African Rift Lakes, other large lakes of tectonic origin	Drilling, Heave compensation and dynamic position or deep water anchoring	8

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Information Need/Gap	What	Why	Where	Technologies	Interest
How Animals use Vision & Light to Orient Themselves in the Water	Visible communication	Know very little, spin-off potential for other technologies, dictate habitat utilization, mating	Deep water, shallows, freshwater vs. saltwater	Standard, photon cameras	9
Hydrothermal Features in Lake Systems	Chemistry, microbiology, nutrient dynamics,	Interesting microbiology, biotech, evolutionary aspects, bioremediation, oceanographic power source for sensors	Crater Lake, Yellowstone Park lakes, African Lakes e.g. Tanganyika, Baikal	Standard	10
Evolutionary Biology	Endemic species, evolution in isolation, interlake comparisons, genetics in large time scales	Fundamentals of evolution of life, island biogeography	Lake Victoria, Lake Malawi, other African lakes, Lake Baikal, compare w/ Great Lakes	Genetic tech, microbiology techniques, capture techniques	11
Seeps/ Non O2 Environments	Same as above	Same as above (except power source)	North shore of Lake Superior, bays, near shore, upper peninsula Superior, Ashland port (Ch..sp?), urban environment	Standard	12
Issue: How do we share archaeological info w/ the public?					
Issue: AUVS have big potential in lakes					
Issue: More use of cross discipline					

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Standard Package: Class IV Vessel w/ Acoustic Mapping; Dive Capability (ROV/AUV/Submersible) w/ Imagery/Video and Sampling Equipment; Precise Positioning System	Standard Partners: EPA; GLERL; Ohio State; Grand Valley State University; Canadian Center for Inland Waters; Canadian Dept of Defense & Coast Guard; Great Lakes WATER Institute; U Mich; Large Lakes Observatory; Mich Tech; USGS; USCG; Univ of Toronto; Illinois Natural History Survey, Departments of Natural Resources

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs

Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Life in 1 m^3 of Water					
IR Laser Scan (100 m res) then Holography (1 m res), 10 year effort	IR laser scan on random samples then holography - take random samples	High but very feasible & low risk	Holography, acoustic Doppler, Std pkg, DNS, fluid simulation, IR laser scan (need low Reynolds# on machine), microchemical sensors	John Hopkins, URI	Scientific: new biota; micro level of how oceans work. Industry: tech approaches are unlimited. Outreach: media (e.g. BBC, Discovery Channel). Regulatory: better vessel management program; bioterrorism.
Archaeology					
Funnel	Broad based survey; then document sites (impt)	L to H depending upon target	STD Pkg, tech divers, acoustic/laser vision system, magnetometer, modeling=Lake level studies	East Carolina University, museums, historical societies, industry, philanthropy, Thunder Bay NMS, Office of Naval Research, Std partners, Smithsonian, academia (Anthro), Native American groups	Scientific: same. Industry: vision system. Outreach: public interest, K-Gray, unlimited, more for prehistoric. Regulatory: management & protection
Targeted	Existing data then document sites (model storm data)	Same as above			
Benthic & Abyssal					
Funnel	Acoustic mapping then ROV work to isolate habitats, ground truthing, sediment, characterize	High	Acoustic scanner, Std pkg, long term video (obs), obs platform (obs), time lapse cameras	Std Partners, Scripps, industry (esp finances - power plants, fishing, fishing support), boating industry, Sea Grant Extension (outreach & funding), Jason Project	Scientific: knowing mating game, life history, what's limiting recruitment, learning more about diporeia decline. Industry: power plants (big time) (e.g. zebra mussel issue), municipal water plants, carbon cycling. Outreach: "huge", public concern, education need. Regulatory: fisheries management, water quality, contaminants
Targeted	Use existing data, groundtruth & characterize	High			
Moored Observation	Moored in key habitat; taking measurements	High (higher risk in winter)			
Mobile Observation	Esp in Winter; ROV/AUV along transect, moving to find key conditions then observe	High (higher risk in winter)			
Eddies/Climate Forcing/Zooplankton					
			Instrumented moorings, drift buoys, ADCPs, instrument arrays, acoustic imaging, STD Pkg, sediment traps	Std Partners, University of Toronto, Oregon State University, Scripps, WHOI,	Scientific: same as yesterday plus fish recruitment. Industry: lake level variations greatly impacts commercial shipping directly. Outreach: std pkg, education, inspiring kids, computer literacy related to science vs. games. Regulatory: major impact on lake level and fisheries management, on tourism protection, on water resource management
Targeted Obs	Choose one location and measure eddies/zooplankton, modeling	High (low risk, comp cost)			
Funnel Obs	5 places in one of large lakes; see how lake responded over two years and choose detailed location and study eddies and zooplankton, modeling	High (low risk, comp cost)			

Worksheet B: Identify Approaches to Address Priority Exploration Information Needs					
Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Add Yellowstone Lake under "Where" list					
Interesting Places					
Funnel	Acoustic mapping, choose sites, ROV, imaging, sediment coring, benthic char & mapping	High	Std Pkg, latest ROV tech, moored instrumentation, ADCPs, acoustic fish finders, modeling	Std Partners, oceanographic institutions, Canadian Geological Survey, industry, Thunder Bay NMS (Karst)	Scientific: new and not understood, same. Industry Outreach: "very cool", potential glamour child. Regulatory: might need to be protected.
Targeted	Choose sites, ROV, imaging, coring, benthic char & mapping	High			
Observation	How conditions change over course of year, instrument mooring w/ current meter arrays, various sensors	High			
Artificial Reefs					
Comparison Study	Before and after comparison (underwater lab concept)	High	Std Pkg, moored sensors & instrumentation, time lapse video, divers (SCUBA), reef design	Std Partners, industry, DNR, University of Waterloo, Fish&Wildlife Service, tourism, recreational divers, University of Windsor	Scientific: same, how reefs interact w/ environment? Industry: aquaculture, recreational diving, biofouling research, charter boat industry (sport fishing). Outreach: very visual. Regulatory: depends on results, should they be doing it or not.
Observation	Watch over time	High			
Targeted	One time examination of new/existing artificial reefs (shipwrecks)	High			
Issues & Notes					
Lack of precise dynamic positioning system aboard vessels					
Blue Heron (87'), EPA vessel (160'), Laurentian (87') = good lake vessels for OE					
How do we educate people on issues in Great Lakes; do not have glamour of the ocean; including choices of what is funded					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps - Great Lakes					
Information Need/Gap	What	Why	Where	Technologies	Interest
Lake Biodiversity; Bio / Geo / chemical processes; origin of Lakes; Origin of species (Evolutionary processes)	Community structures & compositions	Undiscovered areas of bottom; findings new species of Great Lakes; Global Pressures on fresh water resources; Global issues and local pressures on fresh water resources;	Bia Kal Lake; African Rift Lakes, Lake Nicquragua, Great Bear, Great Slave Lake; Titikacica Lake; Yellowstone	Pharmaceuticals	1
Pelagic Habitat - Ecosystem Behavior's; Both physical systems and Benthic Landscape	Intensify systems in time and space scale; Global loss of biological diversity (loss of taxonomy and systematics skills) Human Technologies to resurrect core competence and Knowledge, people & technological interface needed to continue the skills (greater diversity in program - mainly older / white males)	Unknown connections between habitat & behavior; Management Questions (make it exciting for everyone to spend 10% on education & outreach - needs to be automatic, Information technology as part of funding; Interface of scientist and education, Lead time to ensure relevant content; It won' t happen with only a bunch of lone rangers	Biological hot-spots (Benthic & Pelagic Water Columns)	Sensors & Critter Cams - PSATS	2
Biological Transitions Zones; Populations in flux; transportation of organic and inorganic	Identify organisms transitions zones; zebra mussel migrations; mapping of systems	Global climate changes, fish species mobility, numbers; Ranges decline of organisms; Changes in Biodiversity	Green Can Reef; Coastal areas, sea grasses, mangroves, Florida Bay	Time Lapse; Acoustic imaging of sediment layers; microscopic level	2
Integrating in discoveries with accountability Need, Basic research with applied science; Event driven Storms, Surface and Benthic storms;	Distribution of nutrients, biomass & current influences	Important for costal zones; Social economic relevance;	Costal Harbor Estuaries	Moorings (Long Term); High frequency surface radar (CODAR), ADCP's; Development of ecological observatories with (beyond normal sensors); New engineering - adaptive sampling instrument (What, When);	2
Linkage in the atmospheric forcing function; Marine boundary levels influences; Different processes to study and couple to ocean processes cores and eddy's (rings)	Forcing functions in atmosphere; Air - Sea interaction for the exchange of gas mass constitutes;	Driver of Ocean changes; Using the lakes as a closed system for the development of models to build prediction models (small scale processes in the water and air) - Easier to study (logistics)	Translate atmosphere studies techniques in the ocean	New Measurement techniques (RADAR or Lidar)	3
Discover new bio / geo /chemical pathways (distribution in the physical sense)	Identify pathways for compounds	What compounds are influencing the environmental from remote area	Least likely place	Indicator compounds exploration; measurement systems; Platforms for opportunities	3
High Resolution mapping of Great Lakes	Surveys	Discover new features	Large Lakes	Use of UNOLS w/multibeam	4
Cultural resources; Pale Archeology of basin and human interactions	Identify shipwrecks; Submerged shorelines	Increases connections to fresh water and appreciations of Great Lakes resources; Understand dynamics of region	All the Great Lakes basin wide; Green Bay; Saginaw Bay - Deep Water	Better/ Faster multibeam systems	4
Things that live between the rocks	Limited sampling of difficult areas; Deep Reef systems; out crop reefs	Undiscovered areas of bottom; findings new species of Great Lakes	National & International; Large Lake Areas	Small cameras & fiber optics; sucking mechanisms; Different type of new technologies for sampling techniques for heterogeneous area; Sensors have ability to describe the physical substrate in 3 dimension sense	5
Constant monitoring of Pelagic community	Buoy Networks, or an upward looking devices to monitor water column	Unknown interactions in the water column	Lake Michigan for comparison of Older transects	More Adaptive sensors following events	6
Recharge of the all component parts Lake systems, Linkages of rivers estuaries and basin	Use of streams for spawning; Ecosystems approach to water quality; Examine revival of species, Pollutants	River run-off; linkages between estuaries and river fauna, biota complexity issues unique to the freshwater Lakes systems we drink; Land use polices - regulations; water sheds;	Test cases in South East Wisconsin; Collaborative efforts Canada other International entities	Modeling technologies; Maintenance of USGS gauge stations; Broad scale monitoring	7
Charactering ecosystems and other systems; Ice Dynamics	Surveys sampling; systematic surveys; Four dimension; Hydrothermal systems; long term sediment records; rates of change; Seasonal Ice covered areas	Unknown Balance of physical and biological processes; study of ice dynamics	Deep Basin to shallow water volumes; Winter in Great Lakes	Molecular systematics genetics (method to measure diversity); Environmental Tracers	8
Coupling of Modeling and Measurements; Sample strategy/ bio / currents / Atmosphere models -	Areas of gradients (where do you put the resources) at biologically dynamic areas	Citizen science; Balance of empirical measurements with models; helps in planning with catch per unit	Identification models to lead to examples (NASA sulfur model)	Using cruise ships and instruments (Car Ferry towing instruments) Acoustics, sampling water, Image	9

Worksheet A: Identify Ocean Exploration Information Needs/Gaps - Great Lakes					
Information Need/Gap	What	Why	Where	Technologies	Interest
Models can drive questions researchers to answers		effort; verifies the conceptual of the measurements that will be made; environmental predictions; tracking of biological changes; providers a way to bring modelers and empirical measure researchers together (pattern recognition); physical modeling drives biology;		shadow image analysis, microwave radar on bow of ship to measure surface roughness, small scale of hyperspectral imaging; Environmental Tracers	

Information Need - Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Comparative Lake Biodiveristy & Complexity					
Funnel Approach (Phase 1 on several lakes)	Multibeam survey; Physical Ocean sampling; Natural History Survey	Medium	ROVs / AUV / SCUBA / Submersibles / Hyperspectrual Remote Sensors; In-Situ Sensor (Long Term); Small Vessel for Estuaries:	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations;	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Ecological Comparative Functional Group Approach to compare communities with similar landscapes between Lakes; (e.g. Lake Superior: young v.s. Biakal; Old)	Describe landscape census; Looking for midwater scatters	Medium	High Frequency Mid-Level Acoustic Census	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations;	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Targeted Approach on Specific Lakes for Specific things;	- Species Diversity - looking for new species; (3 African Great Lakes); Rapid Assessment survey; Collection of long term Sediment cores; Geo-thermal Vents Systems	High	Digital Imagery	National Geographic; USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations; DOI, USGS BRG; Museums	New Species; Bio-Technology; Fundamental Ecological Principles to Apply to Management; Outreach Human connection to Water Resources; Public Health
Pelagic - Benthic Landscapes, Habitats & Environments					
Focused Applications like the Comparative Funnel Approach with a higher resolution. Details in Ecological Comparative functional Group Approach. [Merge with Interest #6 in winter	Time Series Observations; Investigate during dynamic periods of change "Season of Storms"; Identification of Transport Sampling; Identification of change to community structures across taxonomy;	Medium	Zoo Cam's, Fish Cam's; Buoy Networks, or an upward looking devices to monitor water column; Dockable AUV's; Recycle Oil Riggs on Mid-Lake Ridge; Long Term Observatory	Satellite - National Weather Service; Gas & Electric Industry; Coast Guard, Navy & Army Core of Engineers; NSF, DOI, USGS; Insurance Companies	Understanding Lake Systems; Risk Management of Coastal Resources; Defense Transportation; State Defense National Resources Management; Fisheries;
Discover Bio / Geo / Chem Pathways Air / Sea Interactions					
Discover Bio / Geo / Chem Pathways Linking Atmospheric Forcing coupling of Ocean processing		Identifying boundary fluxes; Identify microscale of physical / chemical processes; eddys & fronts; Data mining & modeling;	Next generation of "FLIP"; Smart Sensors; Swath vessel; Remote Sensing; Super Computer	Navy, Energy Industry, Marine Transportation; EPA; National Weather Service; Canadians	Mass balance understanding in the Great Lakes; Contaminant Transportation; Coastal Meteorological models (Ground Truthing); Marine Weather Predication; Fisheries
High Resolution Mapping of Great Lakes & Paleo Archeological of basin and human interactions					

Observation & Funneled approach	Survey of bottom of Great Lakes - Shallow water mapping; Extention of Coastal Esturiares & Wetlands; Understanding substrates to particle size;	Sub-bottom profiling; using side scanning sonar; Seismic survey; Hyperspectral Imaging from Aircraft; Laser Line Scan	National Oceangraphic Service; Army Core of Engineers; USGS; Power Industry Energy; museums	Discovering where stuff is; Navigations; Fisheries; Cultural Hertiage (Climate history, Lake Levels, drown stream mouths & Inundated cultures);Identifying Exploration Targets; Road maps for research; Inferring Lake processes boundary conditions
Mapping of Great Lakes	Near shore fossil coral reefs (Chicago and similar environments); east-end of Lake Superior; Mid-Lake Reefs; Mid-Lake ridge through Lake Huron; Lake Champlain			
Things that Live between the Rocks				
Targeted Area	Survey of bottom of Great Lakes - Shallow water mapping; Extention of Coastal Esturiares & Wetlands; Understanding substrates to particle size;	Miniaturized exploration / sampling techniques; Fibre optics & Subs, ROV's, AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities	WHOI, Harbor Branch; NGS	Camera Manufactures
Near shore fossil coral reefs (Chicago and similar environments); east-end of Lake Superior; Mid-Lake Reefs; Mid-Lake ridge through Lake Huron; Lake Champlain; Discover origin an maintenance of Reef Dynamics; "Exploring our Groins"				
Crosscutting Technology				
Rapid Scanning Electronic Microscope (Flow-cam)				

South Atlantic Workshop

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Group 1					
Information Need/Gap	What	Why	Where	Technologies	Interest
2. Mapping paleoshorelines and relict reefs (tend to be fish habitats)	Map, ID, characterize, develop baselines for geology, biology, water quality	Understand sea level and paleoclimate changes, foundation for essential fish habitat	Reefs, W. Florida shelf, Keys, shorelines everywhere - shelf edge, Bahamas	bottom sampling, multibeam, subs, side scan, seismic tech, chirp sonar	1
8. Inner shelf	Surficial geology, bathymetry, sediment distribution, biota, habitat distribution, potential fish habitats, groundwater discharge, relationships between biology and geology, physical oceanography - water mass characteristics, invasive species, harmful algal blooms	archaeological potential, sand resources, understanding fish habitat, designate protected areas, hurricane impact - coastal hazards such as erosion, rapid response to natural or man-made catastrophic events, paleoshorelines - coastal evolution	Grays Reef, Georgia coast, Florida coast, SE NC coast least studied, SC coast	SCUBA, multibeam, side-scan, chirp, ROV's, seismic, satellite, Lidar, vibracore, SUB, AUV, basic bottom sampling, moored arrays, multispectral platforms	1
10. Explore canyons and holes	map, characterize, ID, turbidite transport, mineral exploration, gas and groundwater seeps	Unknown, unique isolated habitats, results of unusual geographic processes - history of continental margins, how do they affect oceanography and biological assemblages	Hatteras, Carolina sea trough, Desoto canyon, the Point off Cape Hatteras, Red Snapper Sink Hole - off Jacksonville	Subs, tech diving, sonar, seismic, side-scan, multibeam bathymetry	1
11. Explore shelf break - upper slope	mapping, characterize, ID, intercomparisons	baseline characterization, very productive areas, EFH, upwelling zones, potential for mass wasting, tsunami generation, chemosynthetic communities, fluid flow, evolution of continental margin, mapping low stand deposits, influence of Gulf Stream	S. Atlantic Bight, oculina banks, compare among . . .Cape Canaveral, Hatteras Slope, S.Carolina-Georgia border	Subs, tech diving, ROV's, AUV's, moored arrays, multibeam, side-scan, seismic, chirp	1
16. The Point	extend baseline info, why is it so productive?, map,	unique - meeting of three water currents, very productive, huge potential for natural gas	Just off Hatteras	Subs, mapping, sediment traps	1
12. Bahama Banks	Explore mechanisms behind whiting events, sea level studies, geology, karst studies, low standing reefs, archaeology - shipwrecks, reef studies, coral bleaching, carbonate production, reef sampling/coring for sea level and paleoclimate studies, highly migratory species, fisheries oceanography	Whiting events unknown - Calcium Carbonate in water column, lots of interesting geology, shipwrecks, goes to great depths over short distances - basic exploration, unique, educational applications, carbonate bank evolution, fisheries - provides connectivity to rest of Caribbean, general coral reef health	Tongue of the ocean (TOTO), Florida Straits, Exumas (island chain)	ABLOS (a boat load of stuff), SCUBA, Aquarius and other habitats, remote sensing	2
13. Expanding fisheries (exploitation of new species)	Life history, reproduction, growth rates, all base-line information, education effort	Need baseline information for management of newly exploited species	Opportunistic, region-wide	baited traps, trawling	3
1. SAFMC (South Atlantic Fisheries Management Council) putting areas on map for proposed marine reserve areas - politically driven. Need to explore these regions to ID whether these are appropriate reserve areas biologically, ecologically, etc.	Map, ID, characterize, develop baselines for geology, biology, water quality, determining potential recreational interests, oceanographic parameters	Little is known about proposed regions - most are deep regions, greater than 50m; huge management implications - could fail since they are based on political decisions;	SAFMC has maps, deeper ones off N. and S. Carolina, Georgia, Florida, Gulf of Mexico	Multibeam, AUV, ROV, subs, tech diving, permanently mounted instrument arrays	4
3. Recruitment and spillover mechanisms in MPA networks	Oceanographic parameters/processes, info on spawning, eggs, larvae spillover and transport mechanisms, behavior of early life history stages that effect recruitment	Little known about regions/mechanisms	Region-wide, spawning locations, paleoshoreline ridges such as Pulley Ridge, Dry Tortugas, MPA's and adjacent areas, Charleston Bump	Nanotechnology, AUV (WHOI), multibeam, subs, satellite tags on spawning fish, drifters, moored arrays	4

Worksheet A: Identify Ocean Exploration Information Needs/Gaps					
Group 1					
Information Need/Gap	What	Why	Where	Technologies	Interest
9. Oculina Banks	What is effect of closure? 10 yr limit on no fishing, ID, characterize recruitment and spillover mechanisms, artificial reef impact, comparison with existing baseline studies	Only MPA in S. Atlantic Bight where fishing is not allowed, huge oculina coral region, deep reef at 300ft, oculina destroyed by shrimp trawling and scallop dredging, efforts to reseed right now, will coral self recruit?, unique habitat, assessment of restoration techniques, still don't know a lot about it, no research funds provided to demonstrate effectiveness of MPA in restoring corals and fishes, so needs funding	S. Atlantic Bight	subs, ROV's, tech diving, multibeam, moored arrays, side-scan sonar, chirp	4
4. Exploring Gulf Stream and Florida Current	ID, characterize, map, habitat assessment/map, nutrient cycling, life history/reproductive biology/evolution of life history strategies of fishes	Blake Plateau - Deep, under Gulf Stream/Florida Current, lots of new species found there, difficult access. Portalles Terrace - lots of fish habitat. Unexplored regions	Fauna of Blake Plateau and Portalles Terrace and other significant deep regions in Florida Straits, Miami Terrace	High current subs, ROV's, side scan, multibeam, seismic tech, ADCP, moored instruments, sediment traps, neutrally buoyant sed traps, NEW TECH: develop baited fishing gear - automatic release fishing gear such as magnesium links that dissolve - needs to get to bottom quickly and do it's job of fishing or photographing and then pops up to the surface when done	5
15. Deep sea coral mounts (oculina and lophilia)	map, associated fauna, area, extent, size of mounds, new species	bioprospecting, unknown, new species, MPA implications (?)	400-600m depths, Blake Plateau - Cape Fear to Bahamas	Subs, sonar, sampling tech	5
14. Shelf-wide water column oceanographic studies (physical, biological, chemical)	what causes harmful algal blooms, circulation, nutrient distributions, nutrient flux, mixing, recruitment dynamics, jellyfish (sea nettles)	fisheries impacts, economic impacts - recreation, spawning and distribution patterns, baseline data for rapid response	Region-wide, N. Carolina, Onslow Bay	SABSOON, data buoys, satellite imagery, drifters, general oceanographic sampling - CTD, ADP, water sampling	6
17. Seasonality of upwellings and associated spawning and larval distribution	map locations of upwellings and gyres, measure productivity, sample plankton, measure vertical flux to sea floor, physical/chemical water column characteristics	to understand importance of upwellings, explain or predict recruitment to fisheries, effects on estuarine systems, life history	N. of Cape Canaveral, N. of Charleston Bump - semi-permanent gyres, also smaller ones but don't know much about them - unknown areas	data buoys, moored arrays, satellite, plankton sampling, sediment traps, standard oceanographic sampling - CTD, ADCP, fluorometry	6
5. Bioprospecting	Collect samples of marine organisms, water samples, sediment samples, collect DNA from marine organisms	Need for new pharmaceutical compounds such as antibiotics	Any of regions/projects stated above - opportunistic	Subs, ROV's, low tech shipboard sampling such as trawls and dredges, genomic tech, molecular tech	7
7. Mineral prospecting	manganese nodules, phosphorites, gas hydrates, sand resources for beach nourishment, heavy metals	new energy sources, new mineral resources	Near-shore regions, Region-wide, off Hatteras, Charleston Bump, Blake Plateau, Blake Ridge	Multibeam, Chirp sonar, seismic, ROV's, subs, bottom sampling, corers, grabs, dredges, side scan	7
6. Use example from sheet on chemosynthetic communities		New resources, potential energy source	Blake Ridge, Gulf of Mexico		8
Standard protocol for sampling and data management/storage					
Do's and don'ts of wreck diving - educational campaign					

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs		
Group 1	Standard package: class I/II vessel with acoustic mapping (multibeam, sidescan), dive capability(ROV/AUV/Subs) with imagery/video and sampling equip, precise positioning equipment, real-time information transfer (video, email, web), GIS, bottom samplers, grab samplers, water column sampling - rosettes, CTD, plankton sampling, fish sampling	Standard partners: Universities, USGS, state depts of natural resources, NMFS, NOAA sanctuaries, Sea Grant, NOS, MMS, WHOI, HBOI, NASA, NSF, ONR, Space Grant, COSEE, OE, Army Corps of Engineers, aquariums, museums, archaeologists

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 1					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Bahama Banks					
Submerged habitats	many habitats to observe different regions	medium	coring, sediment traps, water column sampling, std pckg, 3-D seismic, lidar	std partners, CMRC (Caribbean Marine Research Center) at Lee Stocking Island, San Salvador, education partners, Bahama gov't	**scientific –** new knowledge, increased understanding of climate/sea level change, see 'why' from day 1; **outreach –** great opportunities, public interest; **industry –** fishery, recreation, tourism; **regulatory –** fishery
funnel approach	using ships, satellites	high			
targeted approach	sea level data, sediment traps, water column sampling	high			
observation approach	satellite based, remote sensing	high	satellite, remote sensing, lidar		
tracking	satellite telemetry	high	tags		
critter cams	critter behavior	high	cameras		
Shelf to Upper Slope					
observations	moored arrays, satellite, airborne, lidar, drifters	med-high	moored (similar to LEO), ROV observation satellite, airborne	std partners, Oil industry, ocean tech companies, DOD	**science –** observation studies, see 'why'; **outreach –** get students out to sea – lots of opportunities, relevant region – in our back yard; **industry –** recreational, fishery, tourism; **regulatory –** coastal erosion, fishery, MPA's, regulation of shipwrecks
funnel	broad based exploration survey, expansion of marmap monitoring (fisheries monitoring program funded by NMFS to SC)	med-high	std packg, MOCNESS funnel, seismic		
targeted	shelf edge, reefs, hard bottoms, paleoshorelines, spawning locations, sand resources, sediment traps	high	sediment traps, coring		
New tech – mobile habitat (withstand ; baited autonomous trap; drifters released from sea floor	habitat based observation	medium	habitat, SCUBA		
shipboard experience	dedicated estuarine coastal vessel for education and training of next generation of oceanographers to establish monitoring program of data and sample collection – potentially re-outfit Ferrell for this purpose	high			
Expanding Fisheries	baseline information such as growth rates, reproduction, etc.			Standard partners, SAFMC, industry associations such as Coastal Conservation Association and other sport fishing clubs, commercial fishing associations, REEF Environmental Education Association, PADI, NMFS	**scientific –** see 'why'; **industry –** sustainable fisheries; **outreach –** great educational opportunities; **regulatory –** sustainable fisheries
fishery dependent sampling	getting samples from landings	high			
fishery independent sampling	conducting independent surveys to get better estimates of abundance	high	standard package, MOCNESS		

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 1					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
MPA's and EFH's			standard package	Standard package, Islands in Stream, OE, ocean tech industry, NMFS, habitats used in Monitor project	**scientific –** determining effectiveness and design of MPA's, see 'why'; **outreach –** public relations, multidisciplinary, lots of opportunity ; **industry –** lockout tech could be valuable to industry, sustainable fisheries ; **regulatory –** better ability to designate MPA's
funnel	standard funnel package	high	SCUBA, tech diving, lock-out diving from subs		
Targeted	standard targeted				
Tracking	track larvae and fish	high	nanotechnology, satellite tags, SCUBA, tech diving		
Observations	moored arrays, satellites	high	moored arrays with video, satellites, time-lapse video		
passive acoustics	passive acoustic tech	high	passive acoustic array		
Gulf Stream/Florida Current				standard partners, NWS (especially moored), recreation community, fishing, boat industry	**scientific –** see 'why', don't know a lot about dynamics of Gulf Stream, better forecasting; **industry –** storm warning and hurricane prediction, fishery, recreation, tourism, diving community; **outreach –** huge educational/public relations potential; **regulatory –** sustainable fisheries, seasonality of fisheries
funnel	standard funnel	high	standard package, baited autonomous release traps (new tech), ADCP		
targeted		high			
observation	moored current meters at multiple depths, sediment traps	high	AVHRR (sst), SeaWIFS (ocean color), satellites, sediment traps		
drifter	release drifters regularly from position on the sea floor and use satellites to track them	high	neutrally buoyant drifters		
Shelf-wide Water Column Studies					
funnel	standard funnel, water column sampling	high	standard package, moored arrays, upgrading and expanding the SABSOON network, ADCP, permanently moored data buoys, drifting sediment traps (vertex style)	standard partners, CDC	**scientific –** see 'why'; **industry** (HAB's mostly) – tourism, recreation, fishing, toxicology, pharmaceutical, biowarfare; **outreach** (HAB's) – public information; **regulatory** (HAB's) – fisheries, tourism, recreation
targeted	standard targeted, water column sampling	high			
observation- regular	time-series monitoring and collecting water samples	high			
observation – event driven	monitor as event occurs	high			
Prospecting			rock dredging, sand collecting tech, standard package, seismic, sub-bottom profilers, bioprospecting tools	biotech, CDC, Standard partners, local governments	**scientific –** new information, resource ID, oceanographic processes; **industry –** tourism, recreation, biotech; **regulatory –** local governments, coastal zone managers; **outreach –** conservation of resources
funnel	standard funnel	med-high			

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs

Group 1

Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
targeted	standard targeted, Charleston Bump (mg), Blake Plateau (gas hydrates, sand), inner shelf,	high			
Other needs: central sampling repository; central repository for data					
NEW TECH – Improve tech for lock-out diving					

Worksheet A: Identify Ocean Exploration Information Needs/Gaps

Group 2

Information Need/Gap	What	Why	Where	Technologies	Interest	Item #
Shelf to slope transition area; complex habitats – reefs (outer shelf), deep coral banks, canyons	multidiscipline surveys; fisheries; ID community structures; (Assume already have good bathymetric data); characterize content of entire water column (*planned comprehensive surveys); *staged multiyear plan , generate time line	impact of cable laying; oil industry; lack of knowledge of biodiversity; pharmaceutical interest (sponge communities)	Hatteras to Texas	multibeam; ROVs; sampling technologies; HDTV; subs in strong currents; remote sensing of Gulf Stream	16	3
Primary & secondary fish production; understanding geochemical processes	eddy processes; ID drivers of production; lagrangian perspective; food web	management of living marine resources	Charleston Gyre	satellite imaging of SST, SeaWiFS; multidisciplinary ship time; drifters	16	4
Connectivity of habitats on shelf and edge of shelf; trophodynamic study	extent of spawning areas; inventory of habitats and communities; connection between reefs	unknown establishment of MPAs; understanding of energy flow; status/impact assessment	marine protected areas; Hatteras to Texas		16	5
Submerged cultural resources – document status of wrecks; recently uncovered by storms, etc.	systematic surveys; ID targets; consistent survey of coastline areas out to EEZ	management tool; can't protect or investigate what you don't know; historical importance; driven by technology which has allowed public to conduct surveys; prioritize value	Hatteras to Keys; USVI	multibeam	11	1
Mapping currents and eddies and their connection to vertical and horizontal components	ID circulation, temperature discontinuities, current velocities; pH levels	transportation of organisms; ID shipwreck status; effectiveness of no fishing areas	Gulf Stream to inlets	satellites for SST; drifters; buoys; ADCP; AUVs	11	8
Discovery of deep sea minerals, deep sea biota	surveys – subsurface; ocean drilling programs	undiscovered; potential natural resource, cable laying process	Blake Plateau		10	9
Map dead and living muscle & clam communities associated with seeps	compare with subsurface; ID survey	ID habitat impacts; understand the differences in communities between Blake Ridge and Gulf of Mexico	Blake Ridge	multibeam; coring; sub; gas hydrate sensors	10	2
Post data collection access to data/info	central coordination of data repository; coordination with P.I., collaboration among P.I.s to share and publish data; funding for working up data; requirements in grant awards – metadata generation, timelines (derived products vs. raw data); data management system process for collected data – soft data, hard data (jars of samples), data products; graduated approach with sufficient funding	public and other organizations need access to Ocean Exploration mission results; support for direct outreach initiatives	anywhere accessible	GIS; distributed data management systems	6	6
Automated data and metadata system	bridge / ship info feeds into automated / integrated system for cruise report; station data		information systems for ships			7

crosscutting themes:
metadata clearinghouse as data organization process
scientists are at a disadvantage w/ industry when the industries have more data than the science community

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs		
Group 2	"Standard" Package 1 - as described on handout + magnetometer, sidescan, sub-bottom profiler, flow thru system; "Standard" Package 2 - NR1 submarine like vessel; "Standard" Package 3 - mobile habitats	"Standard" Partners - USGS, National Park Service, Navy, States, Universities, SHIPO (State Historic Preservation Office), NMFS, NOS, industry, media, educators, Sea Grant, NASA, NESDIS

Worksheet B: Identify Strategies to Address Priority Exploration Information Needs					
Group 2					
Information Need & Approaches	Description	Feasibility	Enabling Technologies	Partners / Available Assets	Key Benefits
Shelf to slope transition area; complex habitats - reefs (outer shelf), deep coral banks, canyons					impact assessment
1 - funnel approach	survey bottom; physical sampling of water column dynamics	high ($$)	std pkg 1 minus sub	std partners	historical / educational use; industry - ID new things; protection (regulatory); scientific new knowledge, better understanding
2 - targeted	biological survey; sampling structural data; describing wreck structure; wood samples from wrecks; corrosion analysis; sampling substrates, subsurface geology	high - std pkg 1; low - std pkg 2, 3	std pkg 1, 2, 3; HDTV cameras; photo mosaic	std partners	scientific; industry; new species; gas chemistry; resource management
3 - observation	site stabilization; covering and uncovering of wrecks; observe new species; species interactions/behavior; habitat utilization; network of sensors	high - obs system; low - std pkg 3	std pkg 3; multiple cameras/sensors - fiber optic technology	std partners	ID new species; scientific new knowledge
Primary & secondary fish production; understanding geochemical processes					
1 - target on eddies	collect water column, physical data; use satellite imagery; collection of mid/bottom biologics; net and bottom sampling; connecting bio/chem/geo technologies and processes	high	CTD; automated sensors; automated ship - compiling/integrating; management of data; real-time continuous data collection; "conducting cable"; collecting satellite data - SST, SeaWiFS, ARGOS; transmit broadband data		fisheries management; unknown species and processes; impact assessment; education - satellite tracking, real-time video; transmit broadband data
Connectivity of habitats on shelf and edge of shelf; trophodynamic study					
1 - mapping survey	ID connected habitats	high		std partners	MPA location & defining; functionality of MPAs; understanding of unknown - ecological systems; behaviors
2 - targeted; coupling physics and biology	sample; determine source; track history of fish; follow biologics to determine behavior; tagging studies; molecular data analysis	high	spectral technologies; PSATS/conventional tagging; chemical tools		
Submerged cultural resources - document status of wrecks (ships, objects, & settlements); recently uncovered by storms, etc.	ID of sites; site assessment				
1 - systematic survey	submersible onsite; look in historical shipping lanes; sites know in historical records; sub-bottom formation ID	high	std pkg 1 - AUVs; photomosaics; video imagery; multibeam; sidescan sonar; magnetometer; airborne lidar; integrating sensing collection systems and positioning system; real-time video linked to shore	std partners	cultural resource management; education; more effective preservation methods; prioritize sites for recreational, archaeological, historical purposes; designations to national register; outreach; adding to record of "mankind in the sea"; paleo sea level changes
2 - targeted on sites		high			

technology crosscutting:
couple physical, chemical, biological capabilities in data collection management onboard ship
integrate into continuous logging capability
hull mounted ADCPs that work

3 Categorical Tables

This table represents the information sorted by Category regardless of region:

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
171	Alaska	Archaeology	Shipwrecks including, pre WWII, WWII and Later Human Sites	Location and characterization of site; documentation of artifacts; document effects on ecosystem s and food chain	Western Aleutian Islands; Kiska Island; Duke Island (SE AK); Attu Island; SE Alaska; Lynn Canal	Standard Package; archive searching; special equipment for artifacts - lab facilities for preservation & stabilization; human diving	Standard Partners; Museums; Salvage Organization; State Historic Preservation Office
175	Alaska	Archaeology	Archaeological Information on Human Migration	Location and characterization ancient villages; Document migration routes; Document ice records	Fairweather Ground	Standard Package; archive searching; special equipment for artifacts - lab facilities for preservation & stabilization; human diving; very high resolution side scan (w/ backscatter data)	Standard Partners; Museums; Salvage Organization; State Historic Preservation Office
55	Caribbean	Archaeology	Distribution and nature of submerged archaeological resources	For shipwrecks; prehistoric sites; and submerged historical sites determine nature of site and date it	Pan-Caribbean; Mona passage; Southern Bahamas; Florida Keys; Reef areas in general since lots of shipwrecks occur there	Standard Package; Standard diving and archaeological techniques; Historical records; Develop ability to properly core and chemically characterize site; GIS to make successful and broad range availability	Standard Partners; National Endowment for the Humanities; NGO's; private and corporate partners; affinity groups; Discovery Channel; Florida State University; MIT; TAMU; William and Mary; University of Bahamas; Smithsonian
80	Caribbean	Archaeology	Exploration in Time	Review historical records; Examine trading patterns; Utilize Genetic Resources; How were the islands colonized?; How people have used (socio economic; cultural) the oceans in past and how has it affected present condition?; Where are we heading?	Pan-Caribbean	Standard archaeological techniques; ethnographic data; Zoological techniques	Standard Partners
69	Caribbean	Archaeology	Nautical charts from 15th century on - digitize and look at technology and scale to provide historical record ; look at evolution of technology	database - compile current info and map uncharted areas to add to knowledge	US coastal-wide; make this proposal driven to determine 'where'?	mapping tools and technologies	Standard Partners
274	Great Lakes	Archaeology	Cultural resources; Paleo Archeology of basin and human interactions -	Identify shipwrecks; Submerged shorelines; Paleolake lines; ID sites; location; archaeological documentation	All the Great Lakes basin wide; Green Bay; Saginaw Bay - Deep Water; Nearshore Karst features; Straits of Mackinaw Island; Submerged river mouths; Paleolake levels	Standard Package; Sea Water Systems; predictive modeling; side-scan sonar; Better/ Faster multi-beam systems	Standard Partners

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281	Great Lakes	Archaeology	Archaeological Survey & Documentation	Location; documentation; evolution of marine technology; 19th century; effects on biology (good time measurement); influence of currents; also look at known wreck sites; Broad based survey; then document importa nt sites; Search for existing data then document sites (model storm data)	Throughout Great Lakes; deep water; Lake Michigan; Thunder Bay (already have resources) Lake Champlain; Lake Superior; Death's Door; ports; Keweenaw Peninsula; Nearshore Karst features; Straits of Mackinaw I; submerged river mouths; paleolake levels	Standard Package; Technical divers; acoustic/laser vision system; magnetometer; modeling Lake level studies and Interactive (w/ public) cameras; ROVs; multi-beam; subbottom profilers; magnetometer; LIDAR; deep diving cold water diving; active acoustics; moored sensors & instrumentation; time lapse video; divers (SCUBA); reef design	East Carolina University, museums, historical societies, industry, philanthropy, Thunder Bay National Marine Sanctuaries, Office of Naval Research; Smithsonian; academia (Anthro), Native American groups; University of Waterloo, Fish & Wildlife Service, tourism, recreational divers, University of Windsor
15	Gulf of Mexico	Archaeology	Archaeological sites of historical significance	Location and dynamics of archaeological sites of historical significance and cultural sites; wrecks; submerged structures; inventory and characterize what's there; record of sea level change	Candidate sites resulting from prior surveys; edge of Shelf; Bright Banks	Standard Package; Acoustic mapping; single/multibeam; sub/ROVs; AWOIS; video; samples; sub-bottom profiler; SCUBA; sidescan; magnetometers	Standard Partners
113	Hawaii	Archaeology	Understanding population from geological records	Study fossil records; population over geologic time	Kaneohe Bay	Standard Package	Standard Partners
114	Hawaii	Archaeology	Extinct species (fossil reefs)	Study carbonate samples; date; taxonomy	Deeper the better; NW HI; Emperor Seamount chain; Kure and other seamounts up the chain	Standard Package	Standard Partners

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117	Hawaii	Archaeology	Submerged archaeological sites	Near-shore low impact visual survey - Targeted historical research; archives; non-invasive documentation; Mid-water remote sensing - documentation to narrow down to select survey areas; groundtruth targets; Deep water - survey targeted areas then groundtruth	Kure Island - one of most significant wrecks in Hawaii - Naval Historical Center probably interested in this site; protected zone off Pearl Harbor - several subs there - historic landing sites; Nihoa Island and Necker Island; wider Pacific; US Insular Pacific; Hawaiian Islands - Oahu; big island Hawaii; Kure; Pearl Harbor; Midway; Lanai (shipwreck beach); Midway atoll environs (aircraft) ; Alenuinui channel between Hawaii and Maui; dumping grounds SW of Barber's Point Oahu; Historic defensive zone outside Pearl Harbor entrance; Areas near shore to Lahaina; Honolulu Harbor; Hilo Bay; Midway atool environs (aircraft); Alenuinui channel between Hawaii and Maui; dumping grounds SW of Barber's Point Oahu; Historic defensive zone outside Pearl Harbor entrance; Areas near shore to Lahaina; Honolulu Harbor; Hilo Bay; Waialua Bay Waialua Bay	Small vessels; side scan sonar; magnetometer; technical and advanced diving; aerial survey or remote sensing; technology dependent on location and type of wreck - later excavation; conservation; and display - need conservation facilities; microbial technologies; microchip technology	Standard plus the following: National Geographic, Discovery Channel, DOI, State Historic Preservation Division, Hawaii Historical Foundation, Hawaii Community Foundation, Bishop Museum, CMAR, other small NGO's, Smithsonian
140	Hawaii	Archaeology	Natural history of Hawaiian Islands;	Geological controls on marine biota	Hawaiian archipelago; surrounding pelagic waters; NW Hawaii - French Frigate Shoals; SE Hawaii - Big Island	Standard Package; airborne hyperspectral surveys; ground truthing; multi-platforms; mobile observatories	Standard Partners; JAMSTEC;
183	North Atlantic	Archaeology	Regional Archaeological Assessment; Cultural Resources, Chronology Site I.D.	Distribution of Wrecks; Structures; Aircraft; Items of cultural impact; Dump sites Identify all cultural resources with in a region. Characterization of Biological / Geological / Chemical	Regional Assessment Sampling strategy needed (sites with a range of maritime landscapes; Regulation	Standard Package; High Resolution Survey – SUBs / ROVs /AUV's; magnetic Acoustic sensors	USA Core of Engineers; State Governments; Academia; Aquariums; Not For Profit Entities; Science Education; USCG; Navy; Commercial
187	North Atlantic	Archaeology	Character of Deep Water Archaeological sites	wrecks; structures; cultural resources; Priority to older targets; local biota	Target identified by broader area of survey - Virginia Capes;	Standard Package; Deep water sub's ROV's / AUV's / Imagery & Video; remote manipulator; magnetic	Standard Partners

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204	North Atlantic	Archaeology	Shipwrecks (5-10K off New England)	Location; ID & characterize	Close to shore; fishing banks (Georges Banks; Jeffrey's Ledge; Gulf of Maine; shipping lanes - close to shore; "right down the list"	Standard Package; Magnetometer; archival technologies;	Standard Partners
205	North Atlantic	Archaeology	Submerged Prehistoric Sites	Location; ID & characterize; which are still intact; paleogeography; paleo communities; paleo biological assemblages	Shallower than 120m isobaths; near major drainages; coastal embayment; areas of intense fishing activity	Standard Package; Geologic mapping; coring; sub-bottom profiling; side-scan; magnetometer; AUV; Also local knowledge	Standard Partners
222	North Atlantic	Archaeology	Shipwreck Aggregation Sites	Not well documented	Nantucket Shoals; Hatteras; Graveyard of Atlantic; Stellwagen Bank; Boston Harbor entrance; Long Island Sound; Buzzards Bay; Narragansett Bay; entrance to Chesapeake Bay; outer Cape Cod; Casco Bay; & New York Harbor	Standard Package	Standard Partners
305	South Atlantic	Archaeology	Submerged cultural resources	Document status of wrecks; recently uncovered by storms; etc. using systematic surveys or target submersible historical shipping lanes; sites know in historical records; sub-bottom formation identification of targets; consistent survey of coastline areas out to EEZ	Hatteras to Keys; USVI	Standard Package; AUVs; photo mosaics; video imagery; multi-beam; side-scan sonar; magnetometer; airborne LIDAR; integrating sensing collection systems and positioning system; real-time video linked to shore	Standard Partners
237	West Coast	Archaeology	Ships (shipwreck) of importance.	Mapping habitat; multidisciplinary effort; chemo/bio/geo	Workshop results and historical records. Determine location. Luckenbach (San Francisco); Montebello (off Cambria) possible tar issue; Pack Baronesc (entrance of Santa Barbara Channel) bulk cargo of copper sulfate.	Standard Package; Mapping technology; chemical analysis; shipwreck integrity tools	Standard Partners
238	West Coast	Archaeology	Marine Archæology/ Human Habitat	Historical records/archives; traditional knowledge; pick sites; document & remove; Map (paleo shoreline); pick sites; doc & remove; Look at mapping info from other missions then go to sites; Develop strategy on where to look; location; photo documentation; controlled removal; habitat; climate	Develop strategy on where to look; Channel Islands; 140 m below sea level (old coastal level); Santa Barbara Channel; Baja California	Standard Package: High Resolution Imaging; Side-Scan; Magnetometer; removal technology tools; laser imaging; saturation diving; Mapping of shorelines; light subbottom profiling; laser linescan technologies to direct sampling; coring technologies	Insurance industry; EPA; Coast Guard; ONMS; DOS; DOD; states; National Geographic; Discovery; Salvage Industry; (Ole Varmer - NOAA NOS Shipwreck Attorney)

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239	West Coast	Archaeology	Use of pelagic and benthic environments by economically/ecologically important species; by Rare Species	Life history; migration patterns; habitat; population; distribution and abundance; environmental properties; Track location of critter; Beacon to uniquely ID individual; Attach critter cam; fronts/eddies - use remote sensing to ID areas; Listen and observe sounds; LIDAR to monitor; observe; track fish	Basin wide; continental shelf; oceanic; existing protected areas; also see offshore productivity list; fronts and eddies	Standard Package; Satellite tag; data storage tags; satellite remote sensing (benthic and passive); acoustics (passive and active); genetic tools; aircraft; human observation; CODAR; Tag tech Critter cam; LIDAR	Standard Partners; NPS; Military; biogeochemistry academic community; international partners; Stanford Hopkins Marine Station; Census for Marine Life; Moss Landing Marine Laboratory; Packard Foundation
293	Great Lakes	Artificial Habitats	Artificial Reefs	Recruitment; deterioration of cultural material; environmental effect; new vs. used; lab	Artificial reef sites e.g. not too much fishing or commercial activity	Standard Package; Moored sensors & instrumentation; time lapse video; divers (SCUBA); reef design; Active acoustics;	Standard Partners; industry; DNR; University of Waterloo; Fish &Wildlife Service; tourism; recreational divers; University of Windsor
41	Gulf of Mexico	Artificial Habitats	Offshore man-made structures	Zoogeography of man-made offshore structures - oil and gas structures with time-based observations (depth is a very important component; systematic approach); oil and gas structures; Sargassum mat time-based observations at rigs (modeling; observe before and after mats pass rigs); taxonomy; diversity; distribution	Shelf and deep water; intertidal and subtidal structures	Standard package; Largely diving and ROV's; GIS commercial equipment to collect species from rigs; need industrial strength samplers; low tech recruitment plates; SCUBA; imaging; standard sampling techniques; modeling	Recreational fishing communities; big non-profits such as TNC; WWF; Ocean Conservancy; media; BBC; Discovery Channel; academic institutions; industry; National Geographic; standard; high potential for industrial partners;
160	Alaska	Benthic Environment	Relationship of Benthic Features and Essential Fish Habitats	Catalogue the distribution and abundance of the types of species that are in the mesopelagic zone; document the benthic habitats that support important ecosystem components including fish and rare or special species and essential fish habitats	Continental shelf; Gulf of Alaska; Bering Sea; Chukchi Sea; shelf edge and basin of Gulf of Alaska	Standard Package; bottom profiling technologies; optics; satellites; nets; tagging; underwater visual technology; PSATS	Standard Partners; Fishing industry
275	Great Lakes	Benthic Environment	Benthic Communities "Things that live between the rocks" - Limited sampling of difficult areas; Deep Reef systems; out crop reefs; Identify & characterize interaction, effects of exotics, impact of fisheries, compare w/ oceans, food web	Limited sampling of difficult areas; Deep Reef systems; out crop reefs; Identify & characterize interaction; effects of exotics; impact of fisheries; compare w/ oceans; food web	National & International; Large Lake Areas; Lake Superior; compare with Chesapeake Bay and Gulf of Maine	Miniaturized exploration / sampling techniques; Fiber optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities Small cameras & fiber optics; sucking mechanisms; Different type of new technologies for sampling techniques for heterogeneous area; Sensors have ability to describe the physical substrate in 3 dimension sense; long term video observation platform time lapse cameras	Standard Partners, Camera Manufactures; Scripps, industry (esp. finances - power plants, fishing, fishing support), boating industry, Sea Grant Extension (outreach & funding), Jason Project

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283	Great Lakes	Benthic Environment	Benthic Communities	ID & characterize interaction; effects of exotics; impact of fisheries; compare w/ oceans; food web	Lake Superior; compare with Chesapeake Bay and Gulf of Maine	Standard Package; ROVs; Subs; sampling; AUVs; Acoustic scanner; long term video observation platform & time lapse cameras	Standard Partners, Scripps, industry (esp. finances - power plants, fishing, fishing support), boating industry, Sea Grant Extension (outreach & funding), Jason Project
25	Gulf of Mexico	Benthic Environment	Biology in deep benthos	Exploring the deep benthos for biological communities; genomic mapping - non-traditional; cataloguing for biotechnology; inventory and characterize live bottom communities; deep Gulf of Mexico is most heavily studied soft bottom in world; sampling; trawls; subs; genetics; Gulf is a marginal basin - distinct zoogeographic province; mapping identifies hard surfaces - can't trawl or box core; so photo; ROV's; subs; geology important; non-chemosynthetic hard bottom poorly studied; looking for topographic highs; lithoherms; lophilia mounds; sink holes - topographic lows - have lots of fish and corals associated with them	Deep Gulf - start at around 200m	Standard Package; Box cores; trawls; subs; standard sampling; trapping; molecular tech; genetic; mapping; development of new technologies that are cost-effective; photographic surveys; ROV's (limited with currents); subs; 3-D/4-D seismic; need better sampling technologies and photographic video gear; correlating arrays; photographic monitoring; in-situ or repeat visits; chemical monitoring; census of organisms with surveys; vertical hydrophone arrays already in Gulf - can hook up with Gulf of Mexico Research Consortium	MMS; NSF; standard funding structure; FMRI; Sea Grant; Mexico; Cuba; Census of marine life; NIH
132	Hawaii	Benthic Environment	Infaunal organisms	Taxonomy; Sediment ecology	Compare Northwestern Hawaii to others down chain; different depths; soft bottom	Standard Package; Sampling; multi-beam; coring;	Standard Partners
135	Hawaii	Benthic Environment	Characterization of bottom habitats	Broad scale characterization; Match fish species to bottom characteristics; Collect ground truth with deep tow side scan sonar; Seafloor sediments characteristics; Bottom currents	Samoa; Mariana's Islands	Standard Package; ROVs fly through canyon fishing; swath; deep tow; remote sensing of shallow areas; acoustic surveys	Navy; WHOI; University of Hawaii Mapping

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190	North Atlantic	Benthic Environment	Knowledge of Deep Benthic Community	Characterize; Biology; Geology; Bottom Interactions; Ecology Dynamics; Deep Cold Corals; Investigate by using Class I/II Vessel w/Acoustic Mapping; Dive Capability (ROV / AUV / Submersible) w/ Imagery / Video & Sampling Equipment (Not Only ROV / AUV / Sub); Multi-beam; ADCP; Precise Position System; Outreach Capability; Education Component - Fixed Sensors; Sensor Arrays & Mobile Sensors; Space-Base Remote Sensing	Topographic feature of interest	Standard Package; Deep Submersibles; observations; AUV's; Acoustics Imaging; chemical Sampling Techniques	Standard Partners
215	North Atlantic	Benthic Environment	Abyssal Plain	Not well documented	South of Oceanographer & east of Norfolk Canyon	Standard Package	Standard Partners
256	West Coast	Benthic Environment	Deep sea floor	Knowledge of the deep sea floor; surveys via AUVs; sweeping water column; detailed survey then expand; biosphere at seafloor; benthic community; crust & microbial communities; i.e. all deep sea floor communities	Bottom mixed layer to sea floor; deep water North Pacific on coast	Standard Package; Image recognition and software; HDTV & holographic; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities; navigation; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomics on a chip	Standard
336	West Coast	Benthic Environment	Benthic Invertebrates	Abundance of species occupying sub-tidal rock substrates in Washington and Oregon, especially benthic invertebrates	Rock substrates in Washington and Oregon	Standard Package	Standard Partners
78	Caribbean	Boundary Fluxes - Air/Sea	Air/Sea Interactions on the small scale	Document the biological; chemical; and physical processes of the air/sea interface in high resolution over a small area	Caribbean - hurricane source; pan-Caribbean in highly dynamic regions	Develop new sensors to document air/sea interactions on a small scale	Standard Partners

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271	Great Lakes	Boundary Fluxes - Air/Sea	Linkage in the atmospheric forcing function	Forcing functions in atmosphere; Air/Sea interaction for the exchange of gas mass constitutes; Across all lakes; temperature; current; wind speed; barometric pressure; real time chemical composition (monitor 5 places in one of the large lakes; see how lake responded over two years and choose detailed location and study eddies and zooplankton modeling); Application for marine boundary levels influences; Different processes to study and couple to ocean processes cores and eddy's (rings)	Ten largest lakes in the world; Lake Michigan (start where there are problems); need to be strategically position; Lake Champlain; Yellowstone Lake then translate atmosphere studies techniques for application into the ocean environment	Standard Package; Buoys; ADCPs; various sensors; mass spectrometer; wireless comms; real-time web access; instrumented moorings; drift buoys; instrument arrays; acoustic imaging; sediment traps New Measurement techniques (RADAR or LIDAR)	Standard Partners
294	Great Lakes	Boundary Fluxes - Air/Sea	How climate varies in space & time	Climate Change on Timescales of Decades to Millennium	African Rift Lakes; other large lakes of tectonic origin	Drilling; Heave compensation and dynamic position or deep water anchoring	Standard Partners
3	Gulf of Mexico	Boundary Fluxes - Air/Sea	Air/sea interactions	Understanding impact of significant weather (hurricanes; tropical cyclogenesis) on deep ocean; characterize ocean under severe weather and ocean bottom in real-time	Tropical storm tracks in Gulf	Video; acoustic mapping; hydrophones; chem./bio sensors; AUV range capability; AUV stationed underwater - "wake up"; time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectrometer; nutrient sensors; data link; offshore meteorology; satellite data; data buoys; ocean observing systems	NWS (HRD); USN; NMS; NMFS; energy companies; insurance industry; vertical array (ADCP; CTD)
143	Hawaii	Boundary Fluxes - Air/Sea	Climate Change	Feedback of ocean change on biota - through observation approach time series with El Niño events: determine impacts on equatorial Pacific biological pump; long term; carbon fluxes in thermocline	Equatorial Pacific S. America; Galapagos; Toca Tao Arrays	Genetic sampling; satellite (remote sensing); mass spectrometer; sediment traps/cameras; fluorescent signal of phytoplankton species	Standard partners
101	Caribbean	Boundary Fluxes - Basins	Impact of Fresh H2O runoff & Suspended/Dissolved "stuff"	Identify and quantity impact of Fresh H2O runoff & Suspended/Dissolved "stuff"	All Coastal Regions		Standard Partners
288	Great Lakes	Boundary Fluxes - Basins	Carbon Cycling in Lakes; primary productivity, Carbon accumulation, Carbon consumption, compare among lakes	Carbon cycling; primary productivity; Carbon accumulation; Carbon consumption; compare among lakes	Lake Superior; Lake Michigan vs. other lakes	Standard Package; AUVs; primary prod techniques; sediment traps	Standard Partners

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94	Caribbean	Boundary Fluxes - Water Mass	Dynamics of interaction between water masses		Florida Straits; VI - Anegada Passage; loop current production to Florida Straits	Standard Package	Standard Partners
52	Caribbean	Corals - Deep Water	Distribution and status of deep water coral reefs and fish stocks	Collection information on the distribution; taxonomy; abundance; condition; diversity; and size of deep corals and fish stocks;	PR; dry Tortugas; VI; Lang Bank; Shelf bank and wall at VI and PR; Nevassa Island; Columbian Banks; Florida Straits; South end of Cuba; Marquesas; Lots of Places - beyond >20m	Standard Package; remote sensing; technical diving; optics; radio tagging; GIS	Standard Partners; Equipment manufacturers; other commercial operators such as major oil companies; Mineral Management Service (MMS)
27	Gulf of Mexico	Corals - Deep Water	Distribution and status of deep water corals	Diversity; health; size/class distribution; taxonomy	Lophilia Banks - deep coral banks in outer continental shelf - Biosca Knoll; Southern Gulf of Mexico - Sigsbee Knoll and Challenger Knoll	Standard Package; Subs; Alvin or deep ROV	Standard Partners
195	North Atlantic	Corals - Deep Water	Knowledge of Deep and or Cold water Corals	Deep Cold Corals; Investigate by using Class I/II Vessel w/Acoustic Mapping; Dive Capability (ROV / AUV / Submersible) w/ Imagery / Video & Sampling Equipment (Not Only ROV / AUV / Sub); Multi-beam; ADCP; Precise Position System; Outreach Capability; Education Component Biodiversity; Distribution habitat - Fixed Sensors; Sensor Arrays & Mobile Sensors; Space-Base Remote Sensing	Bear Seamount; Oceanographer Canyon; Lydonia Canyon; Nova Scotia & New Brunswick	Standard Package; Magnetic Sensors; Sub-Bottom Profilers; Chemical Sensors; "Tailored" AUV Designed for Archeological Assessment; Sub/ ROV's/ AUV's Video Imagery;	Standard Partners
325	South Atlantic	Corals - Deep water	Deep sea coral mounts (oculina and lophilia)	Map associated fauna; area; extent; size of mounds; new species	400-600m depths; Blake Plateau - Cape Fear to Bahamas	Subs; sonar; sampling technology	Standard Partners
236	West Coast	Corals - Deep Water	Deep water corals	Locate; map; characterize and ID; assessment of threats - existing and emerging; other species supported by habitat	Rocky bottom areas; low sedimentation rates; high currents - below trawl depth. 1-2 KM priority. Monterey Canyon; Astoria Canyon Flanks of seamounts (see above).	Standard Package; Deep camera tows; further development of laser technology; lowlight cameras in rough terrain; slow moving steady AUVs	Standard Partners
53	Caribbean	Corals - Shallow Water	Health and assessment of shallow water coral reefs	"Norms" (coral; fish; biomass) of condition for comparison; One time assessment	Pan-Caribbean shallow water; Marquesas; Tortugas Bank; Islamorada Humps; Riley's Hump	Visual technologies such as SCUBA; hypospectral techniques; aerial photography; develop new diagnostic or early warning technologies - molecular level technologies; remote sensing	Standard Partners; tourism agencies; hotels; hospitality agencies; private foundations;
40	Gulf of Mexico	Corals - Shallow Water	Turbid water coral communities	Presence and distribution; morphology	Northern Gulf region; MS River region	Food chain analysis; light meters and other monitoring equipment; water chemistry	Standard Partners

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170	Alaska	Currents & Water Masses	Circulation Survey	Document subsurface currents;	Western Alaska; Nome; Bering Sea; Chukchi Sea	Standard Package; moorings; remote sensing	Standard Partners
181	Alaska	Currents & Water Masses	Need data and information on large-scale circulation and variability of Beaufort Gyre	Explore largest freshwater reservoir	Beaufort Sea / Arctic Ocean	Standard Package; remote sensing; autonomous platforms; ice-going vessels; moorings	Standard Partners; Canadian Government (Earth Science Sector)
272	Great Lakes	Currents & Water Masses	Discover new bio / geo /chemical pathways (distribution in the physical sense)	Identify pathways for compounds	Least likely place	Indicator compounds exploration; measurement systems; Platforms for opportunities; Next generation of "FLIP"; Smart Sensors; Swath vessel; Remote Sensing; Super Computer	Navy, Energy Industry, Marine Transportation; National Weather Service; Canadians
279	Great Lakes	Currents & Water Masses	Coupling of Modeling and Measurements; Sample strategy/ bio / currents / Atmosphere models - Models can drive questions researchers to answers	Areas of gradients (where do you put the resources) at biologically dynamic areas	Identification models to lead to examples (NASA sulfur model)	Using cruise ships and instruments (Car Ferry towing instruments) Acoustics; sampling water; Image shadow image analysis; microwave radar on bow of ship to measure surface roughness; small scale of hyperspectral imaging; Environmental Tracers; Miniaturized exploration / sampling techniques; Fibre optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities	WHOI, Harbor Branch; NGS
285	Great Lakes	Currents & Water Masses	Mesoscale Eddies - frequencies & importance;Current flow patterns, eddies, mixing process, impact on bio, frequency & importance to ecosystems productivity, chem props	Current flow patterns; eddies; mixing process; impact on bio; frequency & importance to ecosystems productivity; chem props	Lake Superior; other Great Lakes; Yellowstone Lake	Standard Package; Current meters; satellites; ADCP moorings; Instrumented moorings; drift buoys; ADCPs; instrument arrays; acoustic imaging; sediment traps	Standard Partners, University of Toronto, Oregon State University, Scripps, WHOI,
5	Gulf of Mexico	Currents & Water Masses	Loop currents and circulation	Interaction between loop currents; related circulation features & fisheries; and hydrate stability; impact on ecosystems and habitats; relationship between ocean properties and hydrates/beds; HAB formation	Yucatan Channel; shelf break along northern & eastern Gulf; loop current and depth <3km; commercial lease tracts	Standard Package; Hyperspectral sensors; ROVs/AUVs (mobility); HDTV; CTDs & hydrophones; vertical array sensors; data link; remote sensing or utilizing vessel (standard package) or fixed sensors & arrays or data mining; fixed & vessel-based ADCPs; tomography; "tailored" AUV; cameras; and sampling tools; sensors for ID nutrients; drifters; profilant floats	Standard Partners; NWS; energy industries
6	Gulf of Mexico	Currents & Water Masses	Gulf currents on offshore structures	Understanding of Gulf currents on offshore structures; impact on engineering and DESIGN; partnership with platforms	Northern Gulf; energy exploration areas	Instrumented platform; deployed and fixed current meters; drifters; profilant floats	Standard Partners

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110	Hawaii	Currents & Water Masses	Current patterns and gyres and how they are changing	Food production; marine debris deposits; how do they change and how are they affected? (larval transport)	HI Archipelago - large system focus	Satellites; Time observations; Floating instruments; Physical oceanography; Molecular techniques to look at long-term dispersal patterns	Standard Partners
111	Hawaii	Currents & Water Masses	Internal waves	Physical oceanography; Internal tides	Sea mounts - 2002 proposal sites	ADCP; long-term moorings	Standard Partners
193	North Atlantic	Currents & Water Masses	Knowledge of physical & biological processes near fronts; Eddys, Warm and cold rings	Intersections between layers; Relationships to biota; Air-Sea Patterns / Interactions Impact of bottom boundary; Archeological Application; Magnetic Sensors; Data Mining; Bottom mapping & characterization capability; New sampling protocols; Multi Line Arrays and Multi Sensor Arrays	Gulf Stream; Labrador; Gulf of Maine; Long Island Sound	Standard Package; Remote Sensing; Fixed Sensors; Sensor Arrays; AUV's; Archeological Application; Magnetic Sensors; Data Mining; Bottom mapping & characterization capability; New sampling protocols; Multi Line Arrays and Multi Sensor Arrays	Sea Grant Program; Aquariums (Maritime Aquariums @ Norwalk; Mystic, National Baltimore & New England...)
306	South Atlantic	Currents & Water Masses	Mapping currents and eddies and their connection to vertical and horizontal components	ID circulation; temperature discontinuities; current velocities; pH levels	Gulf Stream to inlets	Satellites for SST; drifters; buoys; ADCP; AUVs	Standard Partners
324	South Atlantic	Currents & Water Masses	Exploring Stream and Florida Gulf Current	ID; characterize; map; habitat assessment/map; nutrient cycling; life history/reproductive biology/evolution of life history strategies of fishes; moored current meters at multiple depths; sediment traps; release drifters regularly from position on the sea floor and use satellites to track them; release drifters regularly from position on the sea floor and use satellites to track them	Blake Plateau - deep; under Gulf Stream/Florida Current; lots of new species found there; difficult access; Portalles Terrace - lots of fish habitat; unexplored regions; other significant deep regions in Florida Straits; Miami Terrace;	Standard package; high current subs; ROV's; side scan; multi-beam; seismic tech; ADCP; moored instruments; sediment traps; neutrally buoyant sediment traps; NEW TECH: develop baited fishing gear - automatic release fishing gear such as magnesium links that dissolve - needs to get to bottom quickly and do it's job of fishing or photographing and then pops up to the surface when done; AVHRR (SST); SeaWIFS (ocean color); satellites	Standard Partners; NWS (especially moored); recreation community; fishing; boat industry
159	Alaska	Ecosystem	Bering Sea Fish Habitats (McConnaughey)	Use Bathymetry to understand sediments and habitat; Use hydrography for better understand of tidal data; Understand temporal nature of biology	Gaps in data of Bering Sea - Bristol Bay	Standard Package; Ships of opportunity; interferometric side scan sonar (true swath bathymetry and true backscatter)	Standard Partners; commercial partners; fishing industry
344	Alaska	Ecosystem	Alaska Workshop	Comparison of transects across the eastern, central, and western Aleutians	Aleutians	Standard Package;	Standard Partners;

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119	Hawaii	Ecosystem	Identifying ecologically critical habitats	Temporal / spatial observations; mapping; then direct observations; diversity; location; substrate type; visual information; reflected imagery; community structure; Locating critical habitats with critter cam (Animal borne camera) system; Use existing and historical information	Intermediate depth regions; wide range of depths - mostly moderate depths to deeper depths; NW HI Islands - 2002 sites as specified in 2002 proposals; US Pacific Insular Islands; Guam; Samoa; CNMI	Standard Package plus; ADCP; current meters; multi-beam; Same as tagging technologies; archival capability	Standard partners plus outreach partners, fishermen, National Geographic, Discovery Channel; recreational divers
147	Alaska	Ecosystem - Abrupt Topography	Fjords of southeast and south central Alaska	Contrast recent glaciated landscapes to more stable and tidewater to non-estuaries; Compare tidewater glacial vs. nonglacial; Document substrates for habitat mapping; Detect species distributions; Determine some of physical and biological effects of deglaciation. They have complex oceanographic regimes and teasing out would be good.	Glacier Bay; Prince William Sound; Icy Bay; Substrates for habitat mapping; especially the deep and dynamic fjords (Hooge)	Standard Package; CTD; divers; ships of opportunity; HDTV; Remote Sensing Satellite (ASTER; LANDSAT 7)	Standard Partners; Cruise lines
152	Alaska	Ecosystem - Abrupt Topography	Aleutian Trench	Inventory and document geology (improved mapping) and habitats esp. corals and methane seeps; document these trophic systems; Identify new species	From start to very end of Aleutian Chain	Standard Package; Coring; deep vehicle capabilities; high pressure samplers; deep tow; rock dredging	Standard Partners; JAMSTEC
153	Alaska	Ecosystem - Abrupt Topography	Aleutian Arc	Examine the structural arc; Examine substrates and patterns of coral distribution; Document hydrothermal venting and volcanism; Document biodiversity; biology; and oceanography	Region between the islands and north of the Arc. (abyssal plain); From southern boundaries of the platforms; north to abyssal plain of the Bering Sea	Standard Package; water column methane sniffing; AUVs for mapping broad shallow areas of continental shelf (Much better than using surface ship. MBARI has developed vibracoring system which could be adapted for this project); CODAR	Standard Partners; Russia
154	Alaska	Ecosystem - Abrupt Topography	Canyons	Document rate of the consumption of the physical plate; geochemistry; sediment transport; and volcanism; Examine biology of area; and hot springs seeps; Examine these very interconnected physical systems; Inventory and document geology (improved mapping);	Southeast Alaska; Aleutians; Deep Canyons in Aleutian Fore Arc (POC - Phillip Rigby and Gene Yogodzinksi); Bogoslov; near sub volcanoes; Bering Sea Canyon; Kodiak Seamount	Standard Package; submersible (7000 m) technology that allows you to hold station in strong current; trawls; nets; visualization techniques; physical oceanography tools	Standard Partners
168	Alaska	Ecosystem - Abrupt Topography	Submarine Seamounts	Document evolution of seamounts; circulation; and currents.; Document these ecosystems esp. in the deep water	South central Gulf of Alaska (Gulf of Alaska Seamount Province) e.g. Pratt-Welker Chain; Patton Murray Chain; South of the trench (e.g. Adak Island; Central Aleutians; Atka Island)	Standard Package; new technology (e.g. video to speed up processing); HDTV	Standard Partners; MBARI; Navy

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84	Caribbean	Ecosystem - Abrupt Topography	Impacts of Underwater topography (Sea mounts, pinnacles, reef edges)		warm water environments; banks; shelf edge	Standard Package	Standard Partners
86	Caribbean	Ecosystem - Abrupt Topography	Understanding the ecology and oceanography of Florida Straits	Examine source H2O currents; pollutants; nutrients; and plankton	Florida Straits; VI; Puerto Rico	Standard Package; airborne LIDAR; hyper-/multi-spectral optics (species ID); tracking of tagged fish; human diving technologies; wide bandwidth communications (via LEO SAT); drifters; probes; instrument arrays; fixed ADCP	Standard Partners; state & local agencies; SFOMC; RSMAS; local labs; INS; CIA (DESC); customs; NOPP; OCEAN.US
92	Caribbean	Ecosystem - Abrupt Topography	Trenches	Exploration in trench region to understand the interactions between abyssal depths and shelf waters (including abiotic/biotic constituents)	Puerto Rico Trench and surrounding area	Standard Package; deep submersible; deep ROV/AUV (multipurpose); surface deployed sampling/analysis devices (cost saving versus deep dive); low light optics; communications	Standard Partners
22	Gulf of Mexico	Ecosystem - Abrupt Topography	Cayman Trough	Mapping; plume prospecting; inventory and characterize	Cayman Trough just outside Gulf	CTD's; multibeam	Standard Partners
29	Gulf of Mexico	Ecosystem - Abrupt Topography	Lithoherms	Map; identify and characterize; geology	Between Bahamas and Florida	Standard Package; ROV; towed vehicles; AUV's; subs; geophysical technology	Standard Partners
30	Gulf of Mexico	Ecosystem - Abrupt Topography	Topographic areas with biological communities	Time observation of topographic areas; revisiting topographic features that have significant biological communities; change in bathymetry; time lapse data	Florida Gulf and Keys; Pinnacles off MS/Alabama; Northwest Gulf; Mexico	Time lapse video to observe activity	Standard Partners
34	Gulf of Mexico	Ecosystem - Abrupt Topography	Canyon systems	River-like structures at bottom; microbial communities; geochemical; origin; effects	Orca Basins; smaller brine pools elsewhere; Gulf; MS Canyon	Standard Package; Innovative microbial techniques; sampling techniques; chemical sensors; point sampling with ROV's and subs	Standard Partners
219	North Atlantic	Ecosystem - Abrupt Topography	Gravel Cobble Bottom - continuous features vs. discrete	Not well documented	Corsair; Oceanographer; & Hydrographer Canyons; Stellwagen & Georges Bank; Great South Channel; Jeffrey's Ledge	Standard Package;	Standard Partners

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231	West Coast	Ecosystem - Abrupt Topography	Banks; Fracture Zones; Subduction Zones; Canyons; Sea Mounts	Mapping; subsurface information; sub bottom profiling; biosampling; currents; temperature; chemical description; cores to sample the microbial activity	Cordell Banks; Tanner/Cortez Bank; Oregon Bank complex; Southern California Border Banks; Mendocino; Molokai; Canyons: Big Sur Canyon Complex; Pt Conception complex; Juan de Fuca; Rogue Canyon; Eel River Canyon; Quinalt Canyon; Santa Cruz Canyon; So American canyons (re: strike slip transition); Davidson; Guide; and Pioneer Seamounts; and Gumdrup and Taney Seamounts; Brown Bear and Cobb Seamounts; Bowie Seamount Chain	Chemical sniffers; NMR; genetic fingerprinting; acoustic mapping; long term chemical sampling (e.g. OsmoSamplers)	Standard Partners
251	West Coast	Ecosystem - Abrupt Topography	Biological oasis hot spots	Close in seamounts then remote seamounts; survey triage of hot spots; different tactics for each hot spot; discover; inventory biota; explore; identify processes; find new areas	Seamounts; canyons; upwelling; ocean frontal zones; river plumes; seafloor hydrothermal vents	Standard Package; Imaging - HDTV & holographic; nested acoustics techniques; continuous capability; capturing particle flux; long-term & long-standing observatories; coring; genomic on a chip; generation of sampling technology (give 100x more data) ; genetic markers on AUVs; remote sensing technology on AUV; real time capability; chemical sensor; PSATS; electronic tags; <20 microns technology very important; anecdotal fisherman reports; "Ready 5" capability	Fishing industry (Russians; etc.); MMS
59	Caribbean	Ecosystem - Banks & Basins	Deep basins	Document biogeography and taxonomy; Document physical; chemical; geological; and sediment characteristics	Caribbean basins (4); PR trench	Standard Package; dredging; visual; trawling; trapping; coring.	Standard Partners
109	Hawaii	Ecosystem - Banks & Basins	Banks	Survey; map; ground truthing; sampling; direct observations; ID and characterize organisms as well as features	Penguin Banks; NW HI Banks	Standard Package; genomic technologies; coring; molecular techniques; video live feeds for outreach; Hugo at Loihi volcano; dating technologies	Standard Partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS
213	North Atlantic	Ecosystem - Banks & Basins	Banks	Not well documented	Stellwagen & Georges Bank; Nantucket Shoals; Tillies & Browns Banks; Banquero & Emerald Banks	Standard Package	Standard Partners

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319	South Atlantic	Ecosystem - Banks & Basins	Bahama Banks	Explore mechanisms behind whiting events; sea level studies; geology; karst studies; low standing reefs; archaeology - shipwrecks; reef studies; coral bleaching; carbonate production; reef sampling/coring for sea level and paleoclimate studies; highly migratory species; fisheries oceanography; many habitats to observe different regions; using ships; satellites; satellite based; remote sensing; satellite telemetry; critter behavior; sea level data; sediment traps; water column sampling	Tongue of the ocean (TOTO); Florida Straits; Exumas (island chain)	Standard Package; coring; sediment traps; water column sampling; 3-D seismic; LIDAR; cameras; ABLOS (a boat load of stuff); SCUBA; Aquarius and other habitats; remote sensing;	Standard Partners; CMRC (Caribbean Marine Research Center) at Lee Stocking Island; San Salvador; education partners; Bahamas government
108	Hawaii	Ecosystem - Basins & Banks	Solution Basins	Survey; map; ground truthing; sampling; direct observations; ID and characterize organisms as well as features	Off Maui	Standard Package; genomic technologies; coring; molecular techniques; video live feeds for outreach; Hugo at Loihi volcano; dating technologies	Standard partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS
214	North Atlantic	Ecosystem - Basins & Banks	Basins	Not well documented	East & west Tillies Basin; Georges; Jordan; Wilkinson & Stellwagen Basins	Standard Package;	Standard Partners
217	North Atlantic	Ecosystem - Basins & Banks	Gravel Windows - sediment disturbed & gravel exposed	Not well documented	Stellwagen Basin	Standard Package;	Standard Partners
221	North Atlantic	Ecosystem - Basins & Banks	Glacial Scoured Areas	Not well documented	Northeast Stellwagen Bank; Jordan Basin	Standard Package;	Standard Partners
14	Gulf of Mexico	Ecosystem - Canyons	Characterize canyon processes	Sediment fluxes; turbidity flow; erosion; chemistry; upwelling	Mississippi Canyon; Desoto Canyon; Green Canyon	Standard Package; ROVs/AUVs/subs; video; sampling	Standard Partners
106	Hawaii	Ecosystem - Canyons	Submarine canyons	Survey; map; ground truthing; sampling; direct observations; ID and characterize organisms as well as features; carbon cycling; areas of high productivity; ID and characterize communities; maps	Kaneohe Canyons; Haleiwa Canyon; Waimea Canyon	Standard Package; genomic technologies; coring; molecular techniques; video live feeds for outreach; Hugo at Loihi volcano; Dating technologies; Bait deployment	Standard Partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS
192	North Atlantic	Ecosystem - Canyons	Knowledge of Submarine Canyons	Transport mechanism; Habitat Diversity; Sediment Transport; nutrient transport	Continental Margin; Hudson Canyon; Lydonia Canyon; Varied Geomorphology; Gradient of Human influence	Standard Package; Acoustic Mapping; Non-Destructive Investigations; Robotic Manipulation; Sub-Bottom Profiling; Tools for Sample & Artifact Recovery; Interpretation Tools; Spectral Analysis Tools; Data Mining; Laser Line Scan; Critter Cams	Standard Partners

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211	North Atlantic	Ecosystem - Canyons	Submarine Canyons	Not well documented	All major canyons e.g. Georges Bank canyons and mid-Atlantic canyons e.g. Oceanographer; Veatch; Baltimore; Norfolk; and Wilmington Canyons; Pueblo village communities and the canyon axis; boulder fields; slip stone outcrops	Standard Package;	Standard Partners
316	South Atlantic	Ecosystem - Canyons	Explore canyons and holes	Map; characterize; ID; turbidity transport; mineral exploration; gas and groundwater seeps	Hatteras; Carolina sea trough; Desoto canyon; the Point off Cape Hatteras; Red Snapper Sink Hole - off Jacksonville	Standard Package; Subs; tech diving; sonar; seismic; side-scan; multi-beam bathymetry	Standard Partners
254	West Coast	Ecosystem - Canyons	Canyon systems; gullies (physical; chemical; biology systems)	Hyperpicnal flows; observing systems for long term; investigate submarine rock flows; turbidity currents; internal waves; bridge from shelf to deep sea; develop proxies of variability over time in sediments	West coast; Big Sur Canyon Complex	Standard Package; Forward scatter acoustic techniques; equipment survivability cabling systems; need hardened sensors; "instrumented rock"; long-term instruments that can survive in the canyon environments; temporal exploration; physical ocean modeling	Cable companies; USACE; CSO
57	Caribbean	Ecosystem - Caves	Biodiversity and ecology of marine caves	Characterize and Identify biota using molecular genetics; Map; Determine chemical; geological; biochemical; and physical characterization; geology; Examine for archaeological significance	Bermuda; Bahamas; Yucatan; Greater Caribbean	Standard Package; traditional sensors; satellite photos; technical diving; GIS mapping; cave cam; drilling; data processing and visualization tools; Remote Samplers; coring; smaller tools (bore hole size)	Standard Partners; pharmaceutical industry; biotech; medical manufacturers; equipment manufacturers; USDA; cosmetic companies; NIH; Sea Grant; NCNPR; SIO; Smithsonian; commercial operators such as charter boats; cave divers; fishermen; hunters; taxonomist
220	North Atlantic	Ecosystem - Channels	Channels	Not well documented	Great South Channel; Northern Channel	Standard Package	Standard Partners
151	Alaska	Ecosystem - Extreme Environment - Sea Ice	Characterize and explore extreme environments	Characterize and explore high salinity and low temp environments	Bering Basin / Arctic Ocean	Standard Package; extreme cold technology; biochemical genetic screening; tagging; remote sensing; ice breaker ships; Thermal Imaging; Nation Technical Means; Aircraft; acoustic monitoring	Standard Partners; **Industry**; Navy; US/Canadian/Russian Coast Guard; NSF; Arctic Logistics; BASC (Barrow Arctic Science Contort); VECO Corp.
162	Alaska	Ecosystem - Extreme Environment - Sea Ice	Seasonal(winter) exploration	Biological; geological; cryosphere; biological and physical oceanography;	Continental Shelf spawning area; Bering Sea (Bristol Bay; northern Bering Sea e.g. along the ice edge; central Arctic Basin; whole ice edge); Cook Inlet (issue - other organizations working on it).	Standard Package; extreme cold technology; biochemical genetic screening; tagging; remote sensing; ice breaker ships; Thermal Imaging; Nation Technical Means; Aircraft; acoustic monitoring; full blown submarines	Standard Partners; **Industry**; Navy; US/Canadian/Russian Coast Guard; NSF; Arctic Logistics; BASC (Barrow Arctic Science Contort); VECO Corp.

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163	Alaska	Ecosystem - Extreme Environment - Sea Ice	Sea Ice	Document biology and physical processes going on; Ballena studies; Increased fetch (expanded open ocean). Document change in migration patterns; What is the role of sea ice cover in structuring the marine ecosystem; how does this vary with latitude of the	Nearshore reefs e.g. Camden Bay. Along Arctic barrier islands. Some of the Bering Sea Islands for coastal erosion. Beaufort Seas; Chukchi Sea; Bering Sea	Standard Package; extreme cold technology; biochemical genetic screening; tagging; remote sensing; ice breaker ships; Thermal Imaging; Nation Technical Means; Aircraft; acoustic monitoring; Vessels of opportunity; ice-going vessel; ice moorings; autonomous platforms	Standard Partners; **Industry**; Navy; US/Canadian/Russian Coast Guard; NSF; Arctic Logistics; BASC (Barrow Arctic Science Contort); VECO Corp.
177	Alaska	Ecosystem - Extreme Environment - Sea Ice	Wintertime Trophic Food Web	Identify and catalogue the trophic webs that support birds and mammals in the wintertime; look at what physical processes impact their system; what zooplankton are available for species dependent on their food type; document water column biology (zooplankton)	South Bering Sea; Aleutian Islands (wintertime)	Standard Package; extreme cold technology; biochemical genetic screening; tagging; remote sensing; ice breaker ships; Thermal Imaging; Nation Technical Means; Aircraft; acoustic monitoring; biophysical moorings (winter); new sampling technologies under hi	Standard Partners; **Industry**; Navy; US/Canadian/Russian Coast Guard; NSF; Arctic Logistics; BASC (Barrow Arctic Science Contort); VECO Corp.
58	Caribbean	Ecosystem - Extreme Environment - Sea Ice	Find new vents and seeps (includes fresh water seeps)	Document biogeography and taxonomy; Document physical; chemical; geological; and sediment characteristics	Fresh water communities as well as marine; brine pools; Cayman trench; PR trench; any seismically active area	Standard Package; deployment of platforms that stay in place for long term monitoring; thermal mapping; salinity measurements; technical diving (?) in some of the shallower vents	Standard Partners; phamaceutical industry; biotech; medical manufacturers; equipment manufacturers; USDA; cosmetic companies; NIH; Sea Grant; NCNPR; SIO; Smithsonian; commercial operators such as charter boats, fishermen, hunters; taxonomists;
343	Alaska	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Hydrothermal Vents	Locate isolated biologic communities and sea floor mineral masses	Ingenstrem Depressions; Prochoda (sp) scaorp and related basins; many of the pull-apart basin located along the volcanic line west of Kiska	Standard Package;	Standard Partners;
340	Caribbean	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Kick'em Jenny Volcano	Fully document this active volcano, which is likely to be the next Caribbean island	Kick'em Jenny Volcano (Approximately 4 miles north of Grenada)	Standard Package;	Standard Partners

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1	Gulf of Mexico	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Hydrates and cold seeps/vents; sediment flows and biota	Understanding the relationship between hydrates and cold seeps/vents and between sediment flows and biota (including microbes) and brine pools; discover new species and processes; understand relationships	Hydrate stability zone; 300m - <~3km; northern Gulf; Campeche Banks and Bay; commercial tracts	Standard Package; 3km capable ROV; synthetic aperture sonar; laser line scanner; pressurized hydrate cores; optical spectrometers; mass spectrometers; HDTV; heat flow sensors; resistivity sensors; reusable biosensors; vertical arrays; resistivity sensors; sea-floor probes; geophones; time lapse imaging; AUV "garage"; data recovery technologies; Vessel (standard package) + high resolution seismic; Fixed sensors; Existing data mining - data bases; Remote sensing -surface expression; AUV; sub; sampling; video; moored application	Standard Partners; NAVO; NRL; energy companies
21	Gulf of Mexico	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Chemosynthetic communities	(Subsurface - down several km): oil seeps and vent communities; inventory and characterize; isolated ridge system; new biota; larger geographic context; subsurface 3-D seismic surveys; biogeography (sample); locate plumes	Cayman Trough - major area to explore - lots of unexplored oil seeps; Southern Gulf; Barbados; Trinidad; West Africa - have some taxonomic affinities to those in Gulf of Mexico	Satellite images; oil data; sampling technologies; coring; access industry datasets; chemical sniffers; spectrometers; isotopic work; microbiology; molecular tools; sampling technologies; plume prospecting - do multibeam and then use sensors to look for plumes; standard package; geophysical tools; microbiologists; ecologists; molecular science; towed vehicles; subs; AUV's; look at new technologies	NOAA - PMEL; NSF - Ridge Project; National Geographic; SLOAN Foundation; International interest; NGO's; USGS; Universities; Mexico; EEZ states; WHOI; HBOI; NSF; MMS; DOE; NASA; ONR; Industry pharmacology; oil and gas; biotech; Mexico
43	Gulf of Mexico	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Montserrat	Hydrothermal activity	Montserrat	Standard Package	Standard Partners
46	Gulf of Mexico	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Neuston	Identify and characterize	Sites of persistency of oil slicks; Bush Hill - Northern Gulf	Satellite; sampling	Standard Partners
308	South Atlantic	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Map dead and living muscle & clam communities associated with seeps	Compare with subsurface; ID survey	Blake Ridge	Multi-beam; coring; sub; gas hydrate sensors	Standard Partners
341	South Atlantic	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Heat Flow Measurements	Heat flow measurements on the ocean floor extending hundreds of kilometers normal to, and on either side of, rapidly spreading ridge axes (or hot spots)	Ocean wide near spreading ridge axes or hot spots		

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241	West Coast	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Microinvertebrate assessments	Microinvertebrate assessments e.g. kelp forest assembla ges and soft habitat; microbial ocean; assemblages; interactions; predator/prey relationship	California kelp forests; soft benthic habitats out to 60' (20-60' water depth)	Fiber optics; basic archaeological sampling; species identification	Standard Partners
242	West Coast	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Microbial	In situ sampling and genomic identification & chem; particle counter for small particles - size fractions; cameras - is there a good proportionality ratio that is pretty universal; Microbial assemblages; characterization; taxonomy; role they're playing in larger ecology; bio/geo/chemical processes; bioactive compounds	Could go anywhere and make fundamental discoveries i.e. polar oceans; polluted and non polluted locations to compare microbial assemblages; Throughout water column including the substrate	Moorings; smaller vessels; genomic; chemical analysis tools; In situ genetic sampling;	Biomedical industry; EPA; Fish and Game; local and state health departments; Surfriders
243	West Coast	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	Seeps	Mapping; subsurface information; sub bottom profiling; biosampling; currents; temperature; chemical description; cores to sample the microbial activity	Between Heceta Bank and Hydrate Ridge; along alluvial (sp?) washout of Monterey Canyon.	Chemical sniffers; NMR; genetic fingerprinting; acoustic mapping; long term chemical sampling (e.g. OsmoSamplers)	Standard Partners
244	West Coast	Ecosystem - Extreme Environments - Vents, Seeps, & Volcanoes	High Temperature Hydrothermal Environments	Relatedness	West coast of North and South America (fragments of the Farallon Plate) - interaction of a ridge with a continental margin); opportunity to look thru genetic mutations; how long ago were things isolated?	ROV sampling tools; physical oceanographic sensors; Larval sampling tools	Standard Partners
303	South Atlantic	Ecosystem - General	Primary & secondary fish production; understanding geochemical processes	Collect water colum n; physical data; use satellite imagery; collection of mid/bottom biologics; net and bottom sampling; connecting bio/chem/geo technologies and processes; eddy processes; ID drivers of production; Lagrangian perspective; food web	Charleston Gyre	CTD; automated sensors; automated ship - compiling/integrating ; management of data; real-time continuous data collection; "conducting cable"; collecting satellite data - SST; SeaWiFS; ARGOS; transmit broadband data; multidisciplinary ship time; drifters	Standard Partners
245	West Coast	Ecosystem - General	Chemistry; Physics; Geology	Biogeographic cycling; inputs/outputs cycling	Needs to be done in the context of the other Needs identified	In situ chemical sensors; satellite data; remote sensing;	Standard Partners
291	Great Lakes	Ecosystem - Karst / Ring Depressions	Karst Features in Lake Huron (sinkholes);	Spatial coverage; depth; dimensions; biology; chemistry; local flow pattern	Central Lake Huron	Standard Package; Miniaturized exploration / sampling techniques; Fibre optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities; mass spectrometer	Standard Partners

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292	Great Lakes	Ecosystem - Karst / Ring Depressions	Ring Depressions (400-500 m across; 20-30m deep);	How they formed; influence on distribution of benthic communities; sediments; contaminants; local flow patterns; why not in other lakes	Lake Superior	Standard Package; Seismic reflection profiling; ROVs; Sediment coring; Subs	Standard Partners
267	Great Lakes	Ecosystem - Lakes	Lake Biodiversity;	Bio / Geo / chemical processes; origin of Lakes; Origin of species (Evolutionary processes); Community structures & compositions; Species Diversity - looking for new species; (3 African Great Lakes); Rapid Assessment survey; Collection of long term Sediment cores; Geo-thermal Vents Systems; Describe landscape census; Looking for midwater scatters; Multi-beam survey; Physical Ocean Sampling; Natural History Survey	Bia Kal Lake; African Rift Lakes; Lake Nicquragua; Great Bear; Great Slave Lake; Titikacica Lake; Yellowstone	Standard Package; ROVs / AUV / SCUBA / Submersibles / Hyperspectrual Remote Sensors; In-Situ Sensor (Long Term); Small Vessel for Estuaries: Digital Imagery; High Frequency Mid-Level Acoustic Census	USGS; Country of Lake; Smithsonian; UNEP, UNGEF (United Nations); Developing Nations Organizations; DOI, USGS BRG; Museums
277	Great Lakes	Ecosystem - Lakes	Recharge of the all component parts Lake systems;	Use of streams for spawning; Ecosystems approach to water quality; Examine revival of species; Pollutants	Test cases in South East Wisconsin; Collaborative efforts Canada other International entities	Standard Package; Miniaturized exploration / sampling techniques; Fiber optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities; Modeling technologies; Maintenance of USGS gauge stations; Broad scale monitoring	WHOI, Harbor Branch; NGS
290	Great Lakes	Ecosystem - Seamounts / Ridges	North/South Ridges in Lake Superior;	Origin controversy; distribution of sediment & benthic communities; distribution of fish; influence of bottom currents	Lake Superior (Eastern half); Northern Lake Michigan; Eastern Lake Huron; Bering Sea	Standard Package; Mapping; ROVs; Subs; AUVs; sampling; moorings (ADCP)	Standard Partners
107	Hawaii	Ecosystem - Seamounts / Ridges	Seamounts	Locating unknown seamounts; Identify and characterize communities; Identify new species; Altimetry mapping comparisons; Geoid products; Deep seamount biomass understanding; survey; map; ground truthing; sampling; direct observations with moored stations & deep dives; verifying location; sampling; mapping; deep scattering layer over hydro plumes	Northwestern Hawaii to start comparing altimetry w/ navigation charts; West Mounts; Neckeridge; Hawaiian Islands; Musician Seamounts and then look outside to examine dispersal; evolution; many seamounts have no names; Emperor Seamounts	Standard Package; genomic technologies; coring; molecular techniques; video live feeds for outreach; Hugo at Loihi volcano; dating technologies; better altimetry sensors and data processing; improved spatial coverage; altimetry maps; swath bathymetry; gravity survey; fishing boat watching	Standard Partners, HUGO, telephone companies, outreach partners, National Geographic, Discovery Channel, drug companies, MMS; NESDIS; NASA; Navy
186	North Atlantic	Ecosystem - Seamounts / Ridges	Knowledge of impact of Seamounts on ocean dynamics; Also other abrupt topography	Ocean Currents; Ecosystems; Biogeography; Biodiversity	Bear Mount; New England Seamount chain; Mid Atlantic Ridge; Cashes Ledge; other small features	Standard Package; Sub/ ROV's/ AUV's Video Imagery; Sampling Systems; Acoustic Mapping	Standard Partners

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210	North Atlantic	Ecosystem - Seamounts / Ridges	Seamounts	Systematic documentation	All seamounts e.g. New England seamount chain	Standard Package;	Standard Partners
166	Alaska	Ecosystem - Shorelines to Ledges	Intertidal Zones	Document biodiversity and taxonomy; Identify and characterize; Document archaeology.	Aleutian Islands; Islands in Gulf of Alaska e.g. Shumagins; Kodiak Island Group; Alaskan Peninsula	Standard Package; Via helicopters from ships and Alaska Peninsula; standard biological sampling; LIDAR; acoustic monitoring	Standard Partners; Cruise lines
63	Caribbean	Ecosystem - Shorelines to Ledges	Status of fish stocks and habitat on the Islamorada Hump	Collect information on distribution; taxonomy; abundance; condition; and diversity	Islamorada Hump; Florida Keys	Standard Package; advanced diving; passive acoustics	Standard Partners
85	Caribbean	Ecosystem - Shorelines to Ledges	Knowledge of fisheries habitats	Scope and variability of tropic productivity in reef systems	20-200m	Standard Package; develop acoustic techniques for classification (benthic; reef; and water column organisms); airborne LIDAR; hyper-/multi-spectral optics (species ID); tracking of tagged fish; human diving technologies	Standard Partners; congressional mandate; state & regional; territorial agencies & councils; sport fishing; commercial fisheries; private industry (Ocean Fishing Forecasting Industry); FL Marine Labs (HBOI, MOTE); RSMAS
16	Gulf of Mexico	Ecosystem - Shorelines to Ledges	Mississippi River outflow on habitats	Understand the impacts of Mississippi River outflow on habitats; ecosystems (and secondary fresh water input); Determine river influence on Gulf systems; bio/geo/chem; frontal zones	Flower Garden Banks to FL Keys	Standard Package; Physical sampling; hyperspectral; video/HDTV; towed geo/chem/bio sensors; mass spectrometers; geo/chem/bio sensors; nutrient sensors; sensor arrays; fixed sensors; AUVs; remote sensing; ROVs; drifters; vessel	Standard Partners; NMFS; NASA; USN; NOS; Commercial fishing; sport fishing; EPA; states; NMS; USACE
35	Gulf of Mexico	Ecosystem - Shorelines to Ledges	Shoreline erosion	Subsidence in LA; Gulf of Mexico; erosion rates; habitat loss; sedimentation; storm surge impacts; salt water intrusion; habitat loss; impact; invasive species; impacts on infrastructure	Gulf of Mexico; TX; Alabama; coastal LA	Remote sensing; aerial photo; satellite imagery; maps	Standard Partners
182	North Atlantic	Ecosystem - Shorelines to Ledges	Knowledge of Near Shore environments	Inventory; characterize Measure; habitats; bathymetry; Bio/Geo/Chem of shallow water processes near fronts - colds corals; Archeology; Characterization of Biological / Geological / Chemical	Coastal New England	Shallow water mapping; Sediments; Remote Sensing; in Turbid water; Small vessels; Autonomous Vehicles; Aircraft Archeological Application; Magnetic Sensors; Data Mining; Bottom mapping & characterization capability; New sampling protocols; Multi Line Arrays and Multi Sensor Arrays	USA Core of Engineers; State Governments; Academia; Aquariums; Not For Profit Entities; Science Education; USCG; Navy; Commercial
212	North Atlantic	Ecosystem - Shorelines to Ledges	Ledges	Not well documented	Jeffries Ledge; southern Cashes Ledge; Fippennies; Platts; all along the coast of Maine e.g. smaller coastal ledges	Standard Package;	Standard Partners

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304	South Atlantic	Ecosystem - Shorelines to Ledges	Connectivity of habitats on shelf and edge of shelf; trophodynamic study	ID connected habitats; extent of spawning areas; inventory of habitats and communities; connection between reefs; sample; determine source; track history of fish; follow biologics to determine behavior; tagging studies; molecular data analysis	Marine Protected Areas; Hatteras to Texas	Spectral technologies; PSATS/conventional tagging; chemical tools	Standard Partners
315	South Atlantic	Ecosystem - Shorelines to Ledges	Inner shelf	Surficial geology; bathymetry; sediment distribution; biota; habitat distribution; potential fish habitats; groundwater discharge; relationships between biology and geology; physical oceanography - water mass characteristics; invasive species; harmful algal blooms	Grays Reef; Georgia coast; Florida coast; SE NC coast least studied; SC coast	Standard Package;	SCUBA; multi-beam; side-scan; chirp; ROV's; seismic; satellite; LIDAR; vibracore; SUB; AUV; basic bottom sampling; moored arrays; multispectral platforms
318	South Atlantic	Ecosystem - Shorelines to Ledges	The Point	Extend baseline info; why is it so productive?; map	Just off Hatteras	Subs; mapping; sediment traps	Standard Partners
229	West Coast	Ecosystem - Shorelines to Ledges	Continental Shelf	Benthic; Marine Protected Area; proposed Marine Protected Areas; cables; then go observe; general baseline mapping (high resolution); habitat substrate; geo/bio/chem; current; temperature; ID and characterize	West Coast; existing protected areas; proposed Marine Protected Area cable routes; heavily trawled areas; areas of heavy coastal/urban development. Same locations as above. Also untouched areas.	Standard Package - multi-beam; bioacoustics tech; ADCP; seismic profiling; remote sensing; observatory approach; Standard regular remote sampling techniques; temporal/seasonal sampling tools. Higher resolution remote sampling; processing/visualization tools	Standard Partners; states; sanctuaries; NOS; NOAA hydrographic program
252	West Coast	Ecosystem - Shorelines to Ledges	Nearshore habitat; Archaeological paleoclimate area	Habitat on nearshore (shelf and slope); Archaeological paleoclimate area; targeted anthropogenic impacts; high definition visual surveys; look for arch. sites of previous civilization; look for deeper wrecks; understanding of flows of chemicals; fisheries; understanding biological hot spots; sediment transport; physical; current flow interactions; discover history influences; understanding margin marine boundary layer	0-1000m depth; 0-100m transport	Standard Package; Sidescan; magnetometers; sub-bottom profiling; laser line scan; range gating system; geochemical measuring systems; geology system (porosity); sediment transport system (suspension); generation of sampling technology (give 100x more data); genetic markers on AUVs; remote sensing technology on AUV; etc; real time capability; chemical sensor	Cultural resource organizations; Navy (NAVO); oil companies; museums; NGOs; National Cultural Archival Org; States Historical Preservation; tribes/islanders; ecotourism
157	Alaska	Ecosystem - Slopes	Continental Rise and the Outer Continental Shelf, right down to the Abyssal Floor Plain	Document biological communities and geologic history; Examine this record of continental climate	Arc of the Gulf; Gulf of Alaska continental margin; Bering Sea; e.g. at the base of the margin cutting the canyons	Standard Package; Suite of geological and biological sampling devices; backscatter data; seismic reflection	Standard Partners; Various Commercial Partners

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200	North Atlantic	Ecosystem - Slopes	Study Transitional Areas Between Biogeographic Areas & Shelf Slope Regions	Species distribution and ranges; species dynamics; tropic interaction; invasive; patterns	Georges Bank; Cape Hatteras; 350m isobaths; any biogeographic breaks	Standard Package; Standard Tools	Standard Partners
216	North Atlantic	Ecosystem - Slopes	Slopes (600 to 4000 ft)	Not well documented	Slopes adjacent to ID canyons or seamounts	Standard Package;	Standard Partners
302	South Atlantic	Ecosystem - Slopes	Shelf to slope transition area; complex habitats - reefs (outer shelf), deep coral banks, canyons	Survey bottom; physical sampling of water column dynamics; biological survey; sampling structural data; describing wreck structure; wood samples from wrecks; corrosion analysis; sampling substrates; subsurface geology; site stabilization; covering and uncovering of wrecks; observe new species; species interactions/behavior ; habitat utilization; network of sensors; multidiscipline surveys; fisheries; ID community structures; (Assume already have good bathymetric data); characterize content of entire water column (*planned comprehensive surveys); *staged multiyear plan ; generate time line	Hatteras to Texas	Standard package1,2,3; magnetometer; sidescan; sub-bottom profiler; flow thru system; HDTV; subs in strong currents; remote sensing of Gulf Stream; HDTV cameras; photo mosaic; multiple cameras/sensors - fiber optic technology	Standard Partners
317	South Atlantic	Ecosystem - Slopes	Explore shelf break - upper slope	Mapping; characterize; ID; intercomparisons; moored arrays; satellite; airborne; LIDAR; drifters; shelf edge; reefs; hard bottoms; paleoshorelines; spawning locations; sand resources; sediment traps; broad based exploration survey; expansion of MARMAP monitoring (fisheries monitoring program funded by NMFS to SC); habitat based observation; turbidity transport; mineral exploration; gas and groundwater seeps; dedicated estuarine coastal vessel for education and training of next generation of oceanographers to establish monitoring program of data and sample collection - potentially re-outfit Ferrell for this purpose	S. Atlantic Bight; oculina banks; compare among . . .Cape Canaveral; Hatteras Slope; S.Carolina-Georgia border	Standard package; habitat; SCUBA; moored (similar to LEO); ROV observation satellite; airborne; sediment traps; coring; MOCNESS funnel; seismic; Subs; tech diving; ROV's; AUV's; moored arrays; multi-beam; side-scan; seismic; chirp	Standard Partners; oil industry; ocean tech companies; DOD
144	Hawaii	Ecosystem - Trenches	Trenches	Tonga Trench; deep dive mapping; gas hydrates	Mariana's Trench; Tonga Trench	Extreme deep diving for ROVs; sampling tech	JAMSTEC; NSF - Margins

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138	Hawaii	Ecosystems - Arc	Gaps in exploration in past of arcs	Standard plume techniques at Tonga Kermadec; less than 2% been explored; location of chemical fluxes and plumes; biota; volumetric; geologic signatures; tracing ocean circulation; sensing water column	Euphotic zone in Tonga Kermadec Arc	Standard Package: Airborne remote sensing surveys; XBTS; high precision; standard package; tow-y o	PMEL; GNS; JAMSTEC; NSF - ridge program; American Samoa; NMFS; NMS
270	Great Lakes	Episodic Events	Integrating in discoveries with accountability Need, Basic research with applied science; Event driven Storms, Surface and Benthic storms; Distribution of nutrients, biomass & current influences	Distribution of nutrients; biomass & current influences	Costal Harbor Estuaries	Moorings (Long Term); High frequency surface radar (CODAR); ADCP's; Development of ecological observatories with (beyond normal sensors); New engineering - adaptive sampling instrument (What; When);	Standard Partners
13	Gulf of Mexico	Episodic Events	Loop and related currents to HAB formation	Understanding of relationship of loop and related currents to HAB formation and other species that are not normally seen; discover mechanisms of transport that leads to formation and distribution	West FL shelf; Yucatan Straits (source); E. Texas; northern Gulf	Remote sensing; towed arrays; ROV/AUVs; sampling; drifters (SVP); HDTV	Standard Partners
36	Gulf of Mexico	Episodic Events	Hypoxia phenomenon	Origin; effects	Gulf of Mexico dead zone; look at all river mouths	Collect standard oceanographic parameters	Standard Partners
207	North Atlantic	Episodic Events	Observing Episodic Events & Rare Species e.g. storm, blooms	Short-term events - frequency; strength; intensity; impact; magnitude; compare & contrast	Marine Protected Areas; abrupt bottom topography; areas representative of a range of topographies e.g. ledge vs. flat bottom; e.g. Gulf of Maine; marine mammal habitat;	Camera; observation technology	Standard Partners
253	West Coast	Episodic Events	Plate scale to mesoscale	Plate scale to mesoscale observatory; long-term understanding of episodic events; gyre scale; absorption of CO2; needs thorough mapping effort; collaborative effort; new ways to do oceanography; understanding fluid flux productivity of subduction zones; sources of interplanetary life	Observe 50-70km	Large logistics; huge communications requirements; fiber optic observatory	Telecommunication industry; oil/gas industry; Canada; Germany; etc.
278	Great Lakes	Extreme Environments - Sea Ice	Charactering ecosystems and other systems;	Ice Dynamics Surveys sampling; systematic surveys; Four dimension; Hydrothermal systems; long term sediment records; rates of change; Seasonal Ice covered areas	Deep Basin to shallow water volumes; Winter in Great Lakes	Molecular systematics genetics (method to measure diversity); Environmental Tracers; Miniaturized exploration / sampling techniques; Fiber optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities	WHOI, Harbor Branch; NGS

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287	Great Lakes	Extreme Environments - Vents, Seeps & Volcanoes	High Resolution Spatial & Temporal Zooplankton Measurement over space & time, classification	High resolution zooplankton measurement over space & time; classification	Compare Lake Superior and southern Lake Michigan; 10 largest lakes in the world; Yellowstone Lake	Bigger faster vessels (stationed in Lake Superior); optical plankton counter; towed vehicles; AUVs w/ zooplankton counter; in-situ genetic tech; video image classification tech	Standard Partners
296	Great Lakes	Extreme Environments - Vents, Seeps & Volcanoes	Hydrothermal Features in Lake Systems;	Chemistry; microbiology; nutrient dynamics;	Crater Lake; Yellowstone Park lakes; African Lakes e.g. Tanganyika; Baikal	Miniaturized exploration / sampling techniques; Fiber optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities	Standard Partners
298	Great Lakes	Extreme Environments - Vents, Seeps & Volcanoes	Seeps/ Non-Oxygen Environments - Endemic species, evolution in isolation, interlake comparisons, genetics in large time scales	Endemic species; evolution in isolation; interlake comparisons; genetics in large time scales	North shore of Lake Superior; bays; nearshore; upper peninsula Superior; Ashland Port urban environment	Standard package	Standard Partners
120	Hawaii	Extreme Environments - Vents, Seeps & Volcanoes	Formation of biofilm/microbial mat in extreme environments	Diversity; members of consortia; genome mapping; discovery of new antibiotics; chemistry of the environment	Loihi hydrothermal vent; New Zealand; Mariana's Trench; any extreme environment	Coring technology; Genomic; protein chemistry; microchip; confocal microscopy; develop portable confocal for ship use; small gc/ms; subs and other collection vehicles	Standard Partners
122	Hawaii	Extreme Environments - Vents, Seeps & Volcanoes	Active volcanism	General mapping; Access naval data; Airborne geochemical; Seismic; Passive acoustics; track plumes and trace elements from plumes from air; set up listening arrays; locate features using mapping technology	Am. Samoa; New Zealand; Japan; CNMI; Guam - throughout Pacific	Standard package plus remote sensing; thermal technology; magnetometers; seismology; acoustic technology; mapping technology; passive acoustic arrays; live feed for outreach	Standard partners, Navy, National Geographic, Discovery Channel, deep sea mining community, New Zealand, Japan, Island Nations, Indonesia, Australia, maritime industry, biotech, minerals
133	Hawaii	Extreme Environments - Vents, Seeps & Volcanoes	Understand the Pacific Ocean regarding the origin of life (vent communities, any optimal environments, etc) - A. Funnel (including Tow-Yos)	Interaction between geology; biota; circulation area to target (Tow-Yos - sampling in vertical)	Loihi - volcano; hot spot; Juan de Fuca; cold seeps; Back Arc Basins (Guam; Samoa; Lau)	Standard Package; specific sampling; HDTV; digital camera systems; sampling and incubation systems for culturing organisms	JAMSTEC, University of Washington, PMEL, NASA, GNS, COMB (Center of Marine Biology at Maryland)
142	Hawaii	Extreme Environments - Vents, Seeps & Volcanoes	Sample and map new hot spots; fundamental understanding	Investigate Loihi; Samoa; Louisville Ridge; sampling deep mantle plume; sample volcanic edifice edge of seafloor	Samoa; Loihi	Standard Package; ocean bottom observatories; SOSUS; Sonobuoys Ocean Bottom Seismometer; Acoustic	SOSUS; Isla - Infra Sound Lab (U.N.); bring back Hugo; USGS (Hawaii Volcano); GNS
198	North Atlantic	Extreme Environments - Vents, Seeps & Volcanoes	Chemosynthetic communities (subsurface - down several km): hydrate vents, seeps and vent communities	inventory and characterize; isolated ridge system; new biota; larger geographic context; physical & chemical systems	Mid-Atlantic Ridge	Standard Package; multi-beam geophysical techniques; sampling techniques; satellite imaging; towed vehicles; subs; AUV's look at new technologies	Standard Partners
199	North Atlantic	Extreme Environments - Vents, Seeps & Volcanoes	Knowledge of micro-organisms in the deep sub-bottom	Sea floor Biosphere	Deep water	Standard Package; Deep sampling technology; Ocean Drilling Program	Standard Partners
148	Alaska	Geology & Geomorphology	Documenting climate variability (Molnia)	500 million year record of global climate; Need to examine it to look for variability	Molnia	Standard Package; High resolution geophysics; Coring	Standard Partners; Various Commercial Partners

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149	Alaska	Geology & Geomorphology	Glaciers (Molnia)	How did the glaciers existing in the Bering Sea change over time?; Explore environment created and released by retreating or advancing glaciers; Identify and characterize these environments	Gulf of Alaska continental shelf between Cook Inlet to Canadian Border; southeast Alaska; Glacier Bay	Standard Package; High resolution geophysics	Standard Partners; Various Commercial Partners
165	Alaska	Geology & Geomorphology	Plate Boundary - Strike Slip System	Map and perform water column survey; identify and characterize biota;	icy strait - Canadian border to Alsek River; South of Icy Strait; Fairweather Fault; Yakatat Terrain	Standard Package; basic surveying tools	Standard Partners; Canadian Government (Earth Science Sector); Petroleum Corporations
66	Caribbean	Geology & Geomorphology	Sea floor sediments Holocene (last 10,000 yrs)	What are they? How thick are they and what events do they record?	Florida deep water below 30 meters; VI; PR;	Standard Package; Standard geological sampling; acoustics; develop new technologies - lasers; etc	Standard Partners
9	Gulf of Mexico	Geology & Geomorphology	Bottom boundary dynamics	Understanding of distribution and process details of fluid and gas expulsions; carbonate formations; and seismic activity; knowledge of bottom boundary dynamics	Slope waters <3km; E. Texas to W FL slope; Continental slope; deep water; shelf; Mexico; Cuba; Florida Keys; Florida Gulf	Standard Package; Seismometers; ROVs/subs; video; sampling; map 3-D seismic data; high resolution data	Standard Partners
11	Gulf of Mexico	Geology & Geomorphology	Knowledge of sub-bottom characteristics	Morphology; composition; dynamics	Slope waters <3km	Standard Package; Acoustic sounders (high resolution; seismic); vertical arrays; AUVs	Standard Partners
24	Gulf of Mexico	Geology & Geomorphology	Rivers of warm; dense brine	Heat flow measurements; mapping; origin; effects	Sigsbee Escarpment; Orca Basin	Observations; mapping technologies; CTD; acoustics	Standard Partners
39	Gulf of Mexico	Geology & Geomorphology	Slope stability studies	Debris floats; gas; slopes; faults; gas hydrates; mud flows; inventory and characterization; date features	Continental slope; Mobile West; Florida escarpment; Sigsbee Escarpment	Standard Package; Geotechnical; sidescan sonar; dating techniques; sampling; core samples; high resolution geophysics; multi-beam; sub-bottom systems	Standard Partners
45	Gulf of Mexico	Geology & Geomorphology	Mega-furrows	Origin; physical characterization over time; size; shape; currents	Found between 5-7;000 feet - base of the Sigsbee Escarpment	High resolution bathymetry; geotechnical technologies	Standard Partners
112	Hawaii	Geology & Geomorphology	Paleoshorelines	Sea level information such as history; finding wave notches; ledges; other geomorphological features; lava tubes and marine caves - biology	HI Archipelago (focus in NW and main islands - Midway; Oahu; Necker; main island; Brooks; Lisianski)	Coring technology; Advanced diving; Subs and other vehicles; Multi-beam for mapping; Animal borne instrumentation	Standard Partners
196	North Atlantic	Geology & Geomorphology	Knowledge of Physical Processes related to geomorphology	Mass-gravity movement; Turbidity flows; Hydrate beds; slope instability; chemical analysis	US Continental Margin; Hudson Canyon region;	Standard Package; Sub/ROV/AUV Imagery; Seismic Survey; MCS; Acoustic Mapping	Standard Partners
218	North Atlantic	Geology & Geomorphology	Protected Paleo Shorelines	Not well documented	South of Long Island & Nantucket; Gulf of Maine; Weymouth	Standard Package;	Standard Partners

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314	South Atlantic	Geology & Geomorphology	Mapping paleoshorelines and relict reefs (tend to be fish habitats)	Map; ID; characterize; develop baselines for geology; biology; water quality	Reefs; W. Florida shelf; Keys; shorelines everywhere - shelf edge; Bahamas	Standard Package; Bottom sampling; multi-beam; subs; side scan; seismic tech; chirp sonar	Standard Partners
158	Alaska	High Resolution Bathymetry	Mapping	Collect hydrographic; bathymetric and tidal data - mean low and high water; Document navigation hazards; and biota	Western and northern Alaska; Bristol Bay; Arctic Basin; Bering Sea; Bering Strait; Bering Sea (data gaps areas); North of Sag River; entire shoreline of Beaufort Sea; Cape Lisbourne	Standard Package; tide gauges; Backscatter processing; fathometers in shallow water; LIDAR	Standard Partners
273	Great Lakes	High Resolution Bathymetry	High Resolution mapping of Great Lakes - Survey of bottom of Great Lakes - Shallow water mapping; Extension of Coastal Estuaries & Wetlands; Understanding substrates to particle size; Near shore fossil coral reefs (Chicago and similar environments); east-end of Lake Superior; Mid-Lake Reefs; Mid-Lake ridge through Lake Huron; Lake Champlain	Surveys; Mapping; multi-beam	Lake Superior; Lake Michigan; all the lakes; Yellowstone Lake (done this year); Crater Lake; African Lakes and other large Lakes	Standard Package; Use of UNOLS w/multi-beam; Sub-bottom profiling; using side scanning sonar; Seismic survey; Hyperspectral Imaging from Aircraft; Laser Line Scan; Acoustic mapping; magnetometer; subbottom profiler; ROVs/Subs; Sub-bottom profiling;	National Oceanographic Service; Army Core of Engineers; USGS; Power Industry Energy; museums
289	Great Lakes	High Resolution Bathymetry	Mapping	Mapping; multi-beam	Lake Superior; Lake Michigan; all the lakes; Yellowstone Lake (done this year); Crater Lake; African Lakes	Standard Package; Acoustic mapping; magnetometer; subbottom profiler; ROVs/Subs	Standard Partners
19	Gulf of Mexico	High Resolution Bathymetry	Mapping of the Gulf	Bathymetry	Slopes; shelf regions; western Gulf off Texas coast - East Breaks area; Eastern Gulf; all of Western Florida; 4 reserves closed to fishing - 2 in Tortugas and 2 in West Florida; Northwest Gulf; partner with Mexico to map Yucatan	Standard Package; Multi-beam; subs for ground truthing; utilize backscatter data; standard package; NOAA database; map; select sites; dives - selectively target between topographic features; subs; AUV's; ROV's; intellectual mapping; time series data	Oil and gas industry; MMS; NMFS; seismic companies (SELL); HARTE marine institute; other existing efforts; USGS; Naval Oceanographic service; sea map; GOMP (EPA); academia; NGO's
20	Gulf of Mexico	High Resolution Bathymetry	Mapping between known topographic features	Mapping; inventory and characterization	All over shelf	Mapping technologies; sampling; ROV's; subs; sidescan; towed systems	Standard Partners
127	Hawaii	High Resolution Bathymetry	Charting of seamounts and banks	Mapping with more sophisticated technology	All submerged banks; particularly those that can't be seen through aerial photography; Northwestern Hawaii at 25-100 fathoms	Standard Package with multi-beam	Standard Partners
173	Alaska	Human Impacts	Hazard Dumps	Determine location and chemistry of material; Characterize these sites	Aleutians	Standard Package; hazard sampling techniques; underwater moorings	Standard Partners

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95	Caribbean	Human Impacts	Impacts of Pollution	Anthropogenic impacts on marine mammals and their habitats from ships; blast fishing; Military Ops; Energy Refineries and energy conversion activities	Puerto Rico (super-port); Bahamas; St. Croix; Florida current; deep trenches	SOSUS; deployed arrays; ship surveys; systematic observations	Standard Partners
10	Gulf of Mexico	Human Impacts	Potential threat site location	Location of site of potential threat to the environment and processes near the sites; wrecks; marine debris; dump sites; abandoned platforms	Suspected debris sites; dump zones; wrecks	Standard Package; Sampling (bio/chem/physical); coring; video; acoustic mapper; radiological sensor; networked AUVs; AWOIS; time lapse imagery; video; sector scan sonar; hydrophones; ADCP; chemical sensors; acoustic biomass; phosphorescence sensors; genomic probe; optical spectr ometer; nutrient sensors; data link; single/multi-beam; sub/ROVs; AWOIS; samples; data mining (data bases); fixed sensors and arrays	EPA; NMS; State Governments; NOS (HAZMAT); media?
32	Gulf of Mexico	Human Impacts	Anthropogenic noise	Monitoring natural (biological and geological) and anthropogenic noise; effects of human induced noises on biota; natural noise	MS Delta where whales are located; human built platforms; protected regions; essential habitats	Acoustic technologies; new technologies	Standard Partners
116	Hawaii	Human Impacts	Pollution and marine pathogens	Use pathogen count as a marker	Event driven; Kaneohe Bay; Pearl Harbor; sewage outfall	Molecular biology techniques; genomic	Standard Partners
131	Hawaii	Human Impacts	Safe nuclear waste disposal site				Standard Partners
141	Hawaii	Human Impacts	Understanding biomagnification of pollutants and toxins in the marine food web (similar to large pelagic)	Reef fishes; quantifying toxins	Kona coast; Ecuador; Peru; Alaska	Tracer technologies; genetic markers; sampling and ID tools; stable isotopes will vary; stable isotopes; fatty acid analysis; modeling	Standard Partners; EPA;
197	North Atlantic	Human Impacts	Knowledge of impact of Fishing on Ocean Regions	Health of Benthic Habitat; Census of Marine Life; Archeological Impacts; History of technology;	Grand Banks; Georges Bank; Gulf of Maine; Area where fisheries are expanding into;	Standard Package; Sub/ ROV's/ AUV's Video Imagery; Sampling Systems; Acoustic Mapping	Standard Partners
161	Alaska	Marine Conservation	Essential Fish Habitat	Map and inventory benthic habitats to gain knowledge and understanding impacts of essential fish habitats; candidate areas of protection	Pribiloff Canyons; between Aleutians and shelf break	Standard Package	Standard Partners; fishing industry

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4	Gulf of Mexico	Marine Conservation	Marine Protected Areas	Characterize "deep" Marine Protected Areas (including deep reefs); Identify candidate Marine Protected Areas; Location & dynamics of archaeological sites of historical significance through the use of: vessel (standard package); data mining; manned observatory; fixed sensors and arrays; ID biota that needs protection; habitat characterization	Existing Marine Protected Areas (3 W. FL shelf); Flower Garden Banks; Green Canyon; Mississippi Canyon; Desoto Canyon; PSBL Yucatan Channel	Sub/ROV; deep diving capabilities; manned observatory (human habitat); fixed sensors; AUV; good video; acoustic mapping (single/multi-beam); HDTV; synthetic aperture sonar; laser line scanner; data mining technologies; deep water capability; time lapse imagery; data link	Energy companies; NURC; NMFS; Universities; USN; NIH; state governments; commercial fisheries; sport fishing
321	South Atlantic	Marine Conservation	South Atlantic Fisheries Management Council (SAFMC)	Map; ID; characterize; develop baselines for geology; biology; water quality; determining potential recreational interests; oceanographic parameters; putting areas on map for proposed marine reserve areas - politically driven; need to explore these regions to ID whether these are appropriate reserve areas biologically; ecologically; etc.	SAFMC has maps; deeper ones off N. and S. Carolina; Georgia; Florida; Gulf of Mexico	Multi-beam; AUV; ROV; subs; tech diving; permanently mounted instrument arrays	Standard Partners
322	South Atlantic	Marine Conservation	Recruitment and spillover mechanisms in MPA networks	Oceanographic parameters/processes; info on spawning; eggs; larvae spillover and transport mechanisms; behavior of early life history stages that effect recruitment	Region-wide; spawning locations; paleoshoreline ridges such as Pulley Ridge; Dry Tortugas; Marine Protected Area's and adjacent areas; Charleston Bump	Nanotechnology; AUV (WHOI); multi-beam; subs; satellite tags on spawning fish; drifters; moored arrays	Standard Partners
323	South Atlantic	Marine Conservation	Oculina Banks	What is effect of closure?; 10 yr limit on no fishing; ID; characterize recruitment and spillover mechanisms; artificial reef impact; comparison with existing baseline studies	S. Atlantic Bight	Subs; ROV's; tech diving; multi-beam; moored arrays; side-scan sonar; chirp	Standard Partners
178	Alaska	Marine Microorganisms	Microbes in the Bering and Chukchi Sea	Microbiology and micro-zooplankton sampling; What are the abundant and important microbes and micro-zooplankton of the Bering and Chukchi Sea; Gain knowledge of ecosystem health; Understand long-term variability	Chukchi Sea; Bering Sea	Standard Package; specialized sampling and growth chambers; microscopy	Standard Partners
179	Alaska	Marine Microorganisms	Microscopic Interfaces	Explore unknown micro- / nano-environment; Characterize it including Information on microscopic interfaces of chemistry; microbiology (liquid-solid interface)	shelf; shallow water	Standard Package; micro sampling; micro- and nano-technologies	Standard Partners

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70	Caribbean	Marine Microorganisms	Microorganisms	Knowledge of the diversity; abundance; function; behavior; and identity of marine microorganisms; Impact on Ecosystems and human & habitat health	Water; sediments; organisms; wide range of depths and areas; reefs	Genomics; micro-arrays; conversion of molecular data to signals; real-time remote analysis genomics; new culture techniques	Standard Partners; NIH; Public Health Service; Pharmaceutical Industries; global climate community; reinsurance & insurance industry; Japan; Russia; France; WHOI (ALVIN); energy industries
115	Hawaii	Marine Microorganisms	Marine parasite lifecycles	Documenting parasites; life cycle; primary and secondary hosts	Compare regions to look for pollution relationships; Northwest Hawaii	Fishing; sampling technology; subs; genomic; histopathology; specimen collection	Standard Partners
129	Hawaii	Marine Microorganisms	Marine viruses	What are the effects on carbon and phosphorus cycling?	Oahu; Station Aloha (permanent sampling site - mooring)	Water sampling, virology, bacteriology, molecular biology techniques	Standard Partners
330	South Atlantic	Marine Microorganisms	Chemosynthetic communities	Subsurface - down several km; oil seeps and vent communities; inventory and characterize; isolated ridge system; new biota; larger geographic context	Blake Ridge; Gulf of Mexico	Standard Package; Multi-beam; geophysical techniques; sampling techniques; satellite imaging; towed vehicles; subs; AUV's; look at new technologies	Standard Partners
180	Alaska	Marine Organisms	Where do high latitude organisms go to spend winter	Support for designation of critical habitats	Polynyas - St. Lawrence; Sereniki; St. Matthew	Standard Package; biological and physical tools; benthic sampling; ice breakers; remote sensing; aircraft	Standard Partners; Industry; Navy; US/Canadian/Russian Coast Guard; Native Communities; NSF; Arctic Logistics; BASC (Barrow Arctic Science Contort); VECO Corp.
56	Caribbean	Marine Organisms	All taxa biodiversity inventory	Species inventory; Identify chemical characteristics; Discover and inventory new living resources (non-fishery) with commercial potential	Florida Straits; deep water habitats in Caribbean; location where there is already a lot of information such as Florida Keys or Salt River Canyon in St. Croix (long-term hydrolab mission)	Standard Package; tech diving; develop new sampling tools (new probes; sensors; samplers (miniaturized)) and new tools to keep samples alive (high pressure; low temp containers); taxonomic expertise	Standard Partners; pharmaceutical industry; biotech; medical manufacturers; equipment manufacturers; USDA; cosmetic companies; NIH; Sea Grant; NCNPR; SIO; Smithsonian; commercial operators such as charter boats, fishermen, hunters; taxonomists; many universities
60	Caribbean	Marine Organisms	Learn status and habitats of spawning aggregations of fish	Document distribution; taxonomy; abundance; condition; and life history ; Mechanisms underlying Fish aggregations including pelagic and benthic areas	VI; Nevassa Islands; Columbian Banks (joint treaty); VI; Puerto Rico; Bahamas; Florida Straits; Mexico; Belize; closed areas and Marine Protected Area's	Standard Package; optical technologies; visual observations; technologies that work at night; rebreathers/mixed gas; radio tagging	Standard Partners
77	Caribbean	Marine Organisms	Distribution of marine geographic endemics	Document taxonomy; distribution; and life history	Start at geographically distinct areas such as Florida Keys and compare to US VI	Sampling techniques; molecular genetic techniques	Standard Partners
79	Caribbean	Marine Organisms	Deep Diving and Long Range Marine Mammals	Observe visual behavior; environment; and habitat through use of all senses	Wherever they go!; Several Caribbean wintering ground basins; nursery areas; feeding grounds	Design new technologies - non-invasive and otherwise that follow these mammals	Standard Partners

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98	Caribbean	Marine Organisms	Connection of separated populations (esp. fish)	How Habitats impact each other	Throughout Caribbean		Standard Partners
102	Caribbean	Marine Organisms	Linkage between marine mammals & food source/distribution (includes vertical migrates)			Migrating instruments	Standard Partners
269	Great Lakes	Marine Organisms	Populations in flux; Biological Transitions Zones;	Linkages of rivers estuaries and basin; Use of streams for spawning; Ecosystems approach to water quality; Examine revival of species; Pollutants; Identify organisms transitions zones; zebra mussel migrations; mapping of systems; transportation of organic and inorganic; Identify organisms transitions zones; zebra mussel migrations; mapping of systems	Green Can Reef; Coastal areas; sea grasses; mangroves; Florida Bay	Time Lapse; Acoustic imaging of sediment layers; microscopic level	Standard Partners
284	Great Lakes	Marine Organisms	Abyssal Fish (> 50m)	Life history; impact of invasive species; spawning (where & how especially in winter season); character displacement behavior	Upper Great Lakes; Superior; Huron; Michigan; eastern basin of Lake Erie	Standard Package; ROVs; AUVs; time lapse camera systems planted on bottom in strategic locations; Subs; Acoustic scanner; long term video observation platform / time lapse cameras	Standard Partners, Scripps, industry (esp. finances - power plants, fishing, fishing support), boating industry, Sea Grant Extension (outreach & funding), Jason Project
295	Great Lakes	Marine Organisms	How Animals use Vision & Light to Orient Themselves in the Water;	Visible communication	Deep water; shallows; freshwater vs. saltwater	Standard Package; photon cameras	Standard Partners
297	Great Lakes	Marine Organisms	Evolutionary Biology; Endemic species, evolution in isolation, interlake comparisons, genetics in large time scales	Endemic species; evolution in isolation; interlake comparisons; genetics in large time scales	Lake Victoria; Lake Malawi; other African lakes; Lake Baikal; compare w/ Great Lakes	Genetic tech; microbiology techniques; capture techniques	Standard Partners
12	Gulf of Mexico	Marine Organisms	Distribution and migration patterns of mega fauna	Understanding distribution and migration patterns of marine mammals; Charismatic mega fauna (whales; manta rays; sea turtles; dolphins; whale sharks; etc); response to anthropogenic impacts (noise; other pollution); location; reproduction; general life history questions; genetics	Migration routes; commercial lease tracts (1km contour and loop current events); Gulf shelf; specific topographic features associated with them; man-made platforms	Satellites; various tagging equipment and tech (pop-up; etc); smaller vessels; genetics; endocrinology; biochemistry; Standard package - largely diving and ROV's; GIS commercial equipment to collect species from rigs; need industrial strength samplers; photo equip; ROV's; subs; in-situ cameras; motion sensor cameras; time-lapse cameras; acoustic tags; fixed hydrophones; sensor arrays; tagging; imaging; acoustic; hydro acoustic	Recreational fishing communities; big non-profits such as TNC; WWF; Ocean Conservancy; media; BBC; Discovery Channel; academic institutions; industry

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
26	Gulf of Mexico	Marine Organisms	Genetic connectivity of Gulf ecosystems	Biodiversity; genomic mapping	Upstream and downstream of productive fishery areas – Marine Protected Area's; Keys; Banks; major eddy systems	Genetic technology; plankton tows; traditional sampling techniques; ROV's and subs; deep water collection	Standard Partners
42	Gulf of Mexico	Marine Organisms	Exotic invasive species	Where do they come from?; how did they get here?; where are they successful or not successful?; impact; taxonomy; genetics	Everywhere from coast to far offshore regions	Standard sampling; genetics; taxonomy; modeling	Standard Partners
44	Gulf of Mexico	Marine Organisms	Cross Gulf migratory birds	Migratory birds - songbirds; contribute to database	Western Gulf mainly; Cuba to Florida	Visual observations; radar	Standard Partners
118	Hawaii	Marine Organisms	Animal distribution patterns	Opportunistic (fisheries) Adults only tagging through existing operations such as fishing industry; Targeted Adult tagging - mark-recapture of marine mammals; photo identification; Track over time with tags and acoustic moorings; Genomics (can be part of tagging and/or tracking); collect tissue and analyze; Otolith elemental fingerprinting - collect specimens through HI Arch. and analyze; Larval distribution patterns - collect and identify samples	HI Archipelago (Hoomalu and Mau regions - have at least one site in each region; also big island site); specific relationship between main HI and NW HI and between Johnston Atoll to S. Japan; island to island; bank to bank relationships	Standard Package; RAPT system for tracking; tags; cameras; tracking devices; genomic; develop new faster genomic technologies to be used on ships; current meters; ADCP; molecular techniques to identify larvae; aerial survey; digital ID tools; fingerprinting technology; plankton tows	Standard Partners; plus fishermen - recreational and commercial
121	Hawaii	Marine Organisms	New species/records inventory	Identify new species through existing expeditions recording abundance and diversity; taxonomy; going to areas and habitats that are not well documented	NW HI (2002 proposal sites) - far islands such as Kure and beyond where there have been no subs thus far; get close to N Pacific transition zone; US Insular surveys; maybe look at some equatorial areas for comparison	Standard Package; Plus molecular and genomic techniques; Coring technology; Advanced diving; Subs and other vehicles; Multi-beam for mapping; Animal borne instrumentation	Standard Partners plus fishermen, Smithsonian, New Species Consortium, Sloan Foundation, National Geographic, Discovery Channel, Packard Foundation
128	Hawaii	Marine Organisms	Coelacanth, giant squid, megamouth (obscure, unknown critters)	Location; habitats?; Population distribution; Abundance; Genetics; Images	Indonesia (coelacanth); HI; California (Pacific) (megamouth); New Zealand (giant squid)	Standard Package; Imaging; Subs; ROV's	Standard Partners
134	Hawaii	Marine Organisms	Marine biodiversity - inventory from Hawaii Islands - Deep Marine (>200m - ~6500m or beyond)	Along and around Hawaiian Ridge & link investigators to coordinate discovery	NW Hawaiian Islands to compare species; deep ocean areas	Standard Package; Observatories at depth; deep ocean sampling instruments; low light cameras; video; acoustics; AUVs; deep submersible; ROVs; benthic observatories; in-situ observatories; self cleaning camera lenses; critter camera technology; rugged low light cameras	Standard Partners; JAMSTEC; ONR; National Geographic; NMFS; US Fish & wildlife services

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
139	Hawaii	Marine Organisms	Understand habitat of large pelagic animals	Migration corridors; use of ocean; vertical movements - targeted & observational commercial/research vessels for tagging; satellite data comparisons for behavior patterns; acoustic subsurface surveys (foraging) by attaching instruments to animals - movements; fronts; eddies; interaction with benthos; linking foraging with physical environment	Central Pacific (around Hawaii); coastal Kona (Big Island); ship of opportunity; Hawaiian Ridge	Standard Package; Critter camera technology; satellite archival tags; ARGOS; remote sensing; acoustic surveys; instrument research technologies attached to animals	Standard Partners; Fishery council; Hawaii Long Line Assoc; National Fish & Wildlife; National Geographic; NIWA (New Zealand); CSIRO (Australia); SPREP (South Pacific Regional Environment Program)
188	North Atlantic	Marine Organisms	Distribution of migration & abundance of Large, highly mobile biota	Marine Mammals; Giant Squid; Other Unknown species; Large Deep water Sharks;	Beyond Continental margin	Survey Technique; Tagging & Tracking; Acoustic Imaging; AUV's Imaging	Standard Partners
194	North Atlantic	Marine Organisms	Distribution migration & abundance of Gelatinous plankton	Pelagic Plankton; Vertical migration patterns	Seamounts; Canyons; Along Shelf margin	Sampling Technology; AUV's	Standard Partners
201	North Atlantic	Marine Organisms	Ecosystem Engineers and foundation species (corals, tile fish)	Abundance; location; diversity; new species; establish patterns; Expertise in Taxonomy of Marine Resources; Education; Career Field; Available Pool of Experts	For corals: shelf break; canyons; edges of basins; seamounts; deep and inaccessible; For Mussels: Grand Manan Basin; upper slope environment	Standard Package; Plus time series observations; National & International Standards; Collections Management; Scholarship Programs; Training in Fieldwork for Applicable Disciplines; Sponsoring Existing Entities with Expertise; Expert system can help enable; Graduate Fellowship Programs; Establish Positions (FTE's) for Populations by Existing Professionals; Service Academies; Establish Accommodating University Polices; Establish separate; Collaborative Institute	Standard Partners; Educational Institutions: Sea Grant (?); Museums; Non-Profits
203	North Atlantic	Marine Organisms	Novel Feeding Relationships		Coastal regions near algal beds; offshore basins; depositional environment; marine mammal hotspots	Sampling & stable isotope analyses for food pathways; remote sensors for marine mammals; Critter Cam	Standard Partners
208	North Atlantic	Marine Organisms	Observing Rare Species	For fish & marine mammals: migratory & threatened species e.g. location of bottleneck dolphins; unusual spawning; general behavior	Marine Protected Areas; fish aggregation areas e.g. Stellwagen Bank; ledges; fishing grounds; plane used by marine animals	Cameras; observation technology	Standard Partners

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
320	South Atlantic	Marine Organisms	Expanding fisheries (exploitation of new species)	Establish fishery dependent sampling & fishery independent sampling baseline information such as growth rates; reproduction; etc.; getting samples from landings reproduction; etc.; conducting independent surveys to get better estimates of abundance; life history; reproduction; growth rates; all base-line information; education effort	Opportunistic; region-wide	Standard Package; baited traps; trawling; standard package; MOCNESS	Standard partners; SAFMC; industry associations such as Coastal Conservation Association and other sport fishing clubs; commercial fishing associations; REEF Environmental Education Association; PADI; NMFS
327	South Atlantic	Marine Organisms	Seasonality of upwelling and associated spawning and larval distribution	Map locations of upwelling and gyres; measure productivity; sample plankton; measure vertical flux to sea floor; physical/chemical water column characteristics	N. of Cape Canaveral; N. of Charleston Bump - semi-permanent gyres; also smaller ones but don't know much about them - unknown areas	Data buoys; moored arrays; satellite; plankton sampling; sediment traps; standard oceanographic sampling - CTD; ADCP; fluorometry	Standard Partners
257	West Coast	Marine Organisms	Pelagic animal movement and orientation	How animals find guideposts in the open ocean; animals as ocean explorers; how the populations succeed; behavior patterns; interactions with ocean structures; use of habitat; range and navigation	Basin scale Pacific Ocean; eastern North Pacific Ocean; entire water column	Pop-Up Satellite Archival Transmitters(PSATS); archival tags; acoustic network tracking; active acoustic tracking; ARGOS; imaging systems	University; electronics industry; Census of Marine Life; fishermen (recreational & commercial); conservation groups
88	Caribbean	Ocean Resources - Bioprospecting	Application of new micro/macro organisms on drug discoveries & other industrial products	Biotechnology	Deep reefs; vent; seeps	Standard Package	Standard Partners
202	North Atlantic	Ocean Resources - Bioprospecting	Bioprospecting	Biotech industry	Areas of high diversity; abrupt topo changes; deep within our region and tropical;	Bioprospecting technology; standard sampling technology that capture and keep specimen alive	Standard Partners
328	South Atlantic	Ocean Resources - Bioprospecting	Bioprospecting	Charleston Bump (mg); Blake Plateau (gas hydrates; sand); inner shelf; collect samples of marine organisms; water samples; sediment samples; collect DNA from marine organisms	Any of regions/projects stated above - opportunistic	Standard Package; Rock dredging; sand collecting tech; standard package; seismic; sub-bottom profilers; bioprospecting tools; subs; ROV's; low tech shipboard sampling such as trawls and dredges; genomic tech; molecular tech	Standard partners; biotech; CDC; local governments
176	Alaska	Ocean Resources - Energy & Minerals	Gas Hydrates	Document interaction w/ ocean; Identify and characterize communities associated with them; Map distribution and location; Assess VAMP (Velocity AMPlitude) Structures.	Deep Gulf of Alaska; Beaufort; North Slope; Chukchi; Wrangall Island; Bering Sea Basin	Standard Package; Seismic profiling; sniffers;	Standard Partners

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
2	Gulf of Mexico	Ocean Resources - Energy & Minerals	Gas hydrates	Understanding and determination of location and volume of hydrate resources; classification; chemistry	300m-3km (maybe more) depths; emphasize below 1000m (E. Texas to W. Florida); EEZ; outcroppings; arctic	Acoustic mapping; ROVs; sampling systems; video; sub; AUVs; sensors for gas analysis	Standard Partners
17	Gulf of Mexico	Ocean Resources - Energy & Minerals	Location of new mineral resource deposits	Shell; sand	EEZ	Core samples; ROVs/AUVs	Standard Partners
18	Gulf of Mexico	Ocean Resources - Energy & Minerals	Ocean renewable resources	Ability to generate energy from ocean renewable resources (currents; vents); detailed baseline knowledge of candidate currents/locations	Candidate bathymetry near loop and related currents; vent locations	Instrumented platform; deployed and fixed current meters; drifters; profilant floats	Standard Partners
126	Hawaii	Ocean Resources - Energy & Minerals	Mineral resources	Location; Composition	Johnston sea mount; other sea mounts	Standard Package; multi-beam	Standard Partners
184	North Atlantic	Ocean Resources - Energy & Minerals	Knowledge of Gas Hydrates Provinces	Process of Gas Hydrates potential resources Effects of gases on chemosyntheic communities; Climate Impacts; Slope Quality	US EEZ; Hudson Canyon Region; (fiber Optic Hub)	Submersibles ROV's Sampling Methods	Standard Partners
209	North Atlantic	Ocean Resources - Energy & Minerals	Non Biological Resources (note: this should not be the focus of OE)	Minerals; oil & gas; hydrates; location; occurrence; stability; mixed aggregate	U.S. EEZ	Archive data	Standard Partners
307	South Atlantic	Ocean Resources - Energy & Minerals	Discovery of deep sea minerals, deep sea biota	Surveys - subsurface; ocean drilling programs	Blake Plateau	Standard Package	Standard Partners
329	South Atlantic	Ocean Resources - Energy & Minerals	Mineral prospecting	Charleston Bump (mg); Blake Plateau (gas hydrates; sand); inner shelf; manganese nodules; phosphorites; gas hydrates; sand resources for beach nourishment; heavy metals	Near-shore regions; Region-wide; off Hatteras; Charleston Bump; Blake Plateau; Blake Ridge	Standard Package; Multi-beam; Chirp sonar; seismic; ROV's; subs; bottom sampling; corers; grabs; dredges; side scan; rock dredging; sand collecting tech; seismic; sub-bottom profilers; bioprospecting tools	Standard partners; biotech; CDC; local governments
258	West Coast	Ocean Resources - Energy & Minerals	Crustal processes	Hydrates; fluids (seawater and gases); Crustal processes that affect fluid flow; determination of location and volume of hydrate resources; classification; chemistry; fluid flow; subduction zone; hydrothermal processes; microbial populations and dynamics; fluid pressure and quantification of flow	300m-3km (maybe more) depths; emphasize below 1000m; EEZ; outcroppings; plate scale; active seeps; middle of plates	Standard Package; Acoustic mapping; higher resolution chemical sensors	Standard Partners

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
268	Great Lakes	Pelagic Environment	Pelagic Habitat - Ecosystem Behavior's; Both physical systems and Benthic Landscape; Identifying boundary fluxes; Identify microscale of physical / chemical processes; eddies & fronts; Data mining & modeling; Intensify systems in time and space scale; Global loss of biological diversity (loss of taxonomy and systematics skills) Human Technologies to resurrect core competence and Knowledge, people & technological interface needed to continue the skills (greater diversity in program - mainly older / white males)	Intensify systems in time and space scale; Global loss of biological diversity (loss of taxonomy and systematics skills) Human Technologies to resurrect core competence and Knowledge; people & technological interface needed to continue the skills (greater diversity in program - mainly older / white males)	Biological hot-spots (Benthic & Pelagic Water Columns)	Sensors & Critter Cams - PSATS; Zoo Cam's; Fish Cam's; Buoy Networks; or an upward looking devices to monitor water column; Dock-able AUV's; Recycle Oil Riggs on Mid-Lake Ridge; Long Term Observatory	Satellite - National Weather Service; Gas & Electric Industry ; Coast Guard, Navy & Army Core of Engineers; NSF, DOI, USGS; Insurance Companies
276	Great Lakes	Pelagic Environment	Constant monitoring of Pelagic community - Buoy Networks, or an upward looking devices to monitor water column	Buoy Networks; or an upward looking devices to monitor water column	Lake Michigan for comparison of Older transects	Miniaturized exploration / sampling techniques; Fiber optics & Subs; ROV's; AUV's; Dynamic Positioning Systems or ROV's / AUV's capabilities; More Adaptive sensors following events	WHOI, Harbor Branch; NGS
280	Great Lakes	Pelagic Environment	Life in one cubic meter of water; Seasonal change, species change, ID & characterize, transition rates, feeding rates, all of the rates	Seasonal change; species change; ID & characterize; transition rates; feeding rates; all of the rates	Contrast temperate vs. tropical; nearshore fresh vs. salt; contrast different parameters	Holography; acoustic Doppler; DNS; fluid simulation; IR laser scan (need low Reynolds# on machine); micro-chemical sensors; AUVs; ROVs; subs; sampling; neutrally buoyant chemostats; low impact; low Reynolds #; new tech	John Hopkins, URI
38	Gulf of Mexico	Pelagic Environment	Mid-water exploration	Characterization of organisms	Gulf; off mouth of MS river - resident population of sperm whales over 1;000m line so there must be a resident population of giant squid; Straits of Yucatan and Straits of Florida - Gulf connections	Moch-ness; imagery; sensing; new technologies	Standard Partners
189	North Atlantic	Pelagic Environment	Deep Pelagic Realm	Characterize; Biology Dynamics	Sea Mount & Canyons Along the Continental shelf Greater 1000 meter & meso	Standard Package; Deep Submersibles; observations on a broader scale; AUV's; Acoustics Imaging; chem; Bio Sensor	Standard Partners
206	North Atlantic	Pelagic Environment	Pelagic Realm - surface to deep sea	What's there? Species diversity issues; location; ID and characterize; function; what's there to exploit & conserve; patterns	Beyond shelf break e.g. Oceanographer Canyon and south	Standard Package; Submersibles; ROVs; acoustics; sampling tools to collect gelatinous organisms	Standard Partners

ID	Workshop	Category	Information Need/Gap	What	Where	Enabling Technologies	Partners
326	South Atlantic	Pelagic Environment	Shelf-wide water column oceanographic studies (physical, biological, chemical)	What causes harmful algal blooms; circulation; nutrient distributions; nutrient flux; mixing; recruitment dynamics; jellyfish (sea nettles); water column sampling; time-series monitoring and collecting water samples; monitor as event occurs	Region-wide; N. Carolina; Onslow Bay	Standard Package; moored arrays; upgrading and expanding the SABSOON network; ADCP; permanently moored data buoys; drifting sediment traps (vertex style); satellite imagery; drifters; general oceanographic sampling - CTD; ADP; water sampling	Standard Partners
230	West Coast	Pelagic Environment	Midwater	Species diversity; ID and characterize; food web; link between upper water and benthic water; how the midwater functions in this role; evolutionary relationships; geographic relationships; connectivity	Gross global sampling (have some info on Japan and Monterey Bay)	Standard Package; Suction samplers; insulated compartment; observation & tracking technology; large samplers (new tech); collection tech; AUVs that follow; critters (new tech); Genetic tools; ROVs for filming; sampling and observing behavior; HDTV video very useful; establishing strobe frame photography at some time series sites to get understanding of change of abundance	Standard Partners; HBOI; Canadian ROPOS; MBARI; JAMSTEC (Japan); National Geographic Society; Discovery; MBA; aquaria
250	West Coast	Pelagic Environment	Deep sea water column	Knowledge of the deep sea water column (largest biomass on planet); biota - what organisms exist (distribution; abundance; dynamics)	Bottom mixed layer to sea floor; deep water North Pacific on coast	Standard Package; Image recognition and software; improving control systems for ROVs - adapt to situations; software development; flow cytometers for microbe levels (refinement in technologies); higher flow sampling for midwater communities; nested acoustics techniques; continuous capability; capturing particle flux; genomic on a chip	Standard partners
255	West Coast	Pelagic Environment	Euphotic zone productivity	Productivity of ocean in euphotic zone; understanding life stages of organisms; discover new members; <20 microns (includes viruses; parasites); spatial structures (scales); need balance equation	Euphotic zone; Central Gyre; Monterey Bay	Standard Package; New genetic methods; new techniques for energy flow thru life form systems; genetic probes; active fluorescence; in-situ visualization; observation techniques	Standard Partners; Russia; Poland; agriculture companies; commercial fisheries; remote sensing (NASA)
167	Alaska	Sound in the Ocean	Characterize naturally occurring sounds	Listen to seismic acoustics; fauna acoustics; Marine mammals; and fish; Use acoustics to determine migration paths	Aleutians; SE Alaska; Aleutian Arc; Bering Sea	Hydrophones; observing system(s);	Standard Partners
123	Hawaii	Sound in the Ocean	Ocean acoustics		Hawaii Archipelago (Northwestern and main Hawaii mapping); Guam; CNMI; Am. Samoa; deeper areas	Sonar - active and passive; use subs and other vehicles for in-situ measurements; archival measurements	Standard Partners

4 Supplemental Comments

Workshop invitees and participants were provided contact information to forward any additional comments regarding the workshops or the future of Ocean Exploration. The workshop facilitators made every effort to incorporate all supplemental comments into the workshop tables found in Section 3, Workshop Results, of Volume I. The remaining comments not incorporated in Volume I have been sorted by region and reported below.

Caribbean Region

Future of Ocean Exploration

Ex• plo• ra• tion: To search or range over for the purpose of discovery.

Dis• cov• er• y: The initial act of finding or observing.

In his book, "The Coming of the Golden Age: A View of the End of Progress", published in 1969, Dr. Gunther Stent argued that the period of intensive, basic scientific investigation is coming to an end because science will soon have solved enough societal problems that life will be too cozy for tax payers to justify supporting the increasingly expensive experiments necessary to answer the last remaining difficult science questions. John Horgan, in his recent book "The End of Science", argues similarly, that most of the tough questions about our world and universe have been answered and what is left is simply filling in the decimal places.

Perhaps this view has merit as it applies to many fields of physics, including hydrodynamic modeling and global ocean circulation. This view, however, is a bit optimistic in as far as our knowledge of biological processes. True, we have started to unravel the mysteries of the genetic code, but we are nowhere near using that information to define all of the possible forms of life that can result. One could also argue that through quantum physics, we have the ability to describe any possible chemical reaction. However, the total number of all possible reactions is so large that we could not possibly investigate them all systematically and our knowledge base is too small to even narrow down our investigation to a manageable subset of the most important reactions. There are no theories to guide us in these questions.

How do the related roles of exploration and discovery factor in? The former is the determined pursuit of the latter and the latter is the catalyst for new theory and models. So, new ideas of our world and universe must come from new exploration. To say that we have formulated the definitive model, and therefore the end of scientific enquiry, is to say that we have observed every important condition, or at least the vast majority of all possible important conditions, within the model domain and that these observations agree with model predictions to such an extent the underlying theory must be accepted as fact. Without on-going exploration, we make the assumption that the probability of observing a uniquely new condition that does not agree with the recognized model is very low. This would be the scientist's view of Stent's societal cost-benefit analysis of scientific support. This, for example, is the situation in modeling global ocean circulation where we have a high degree of confidence in the equations of state and model accuracy is a function of our ability to define the boundary conditions. It could also be argued that we are approaching this situation, if we are not already there, as it applies to marine ecosystems that are based on photosynthetic primary production. While there is a great deal of disagreement between model results and observations, the underlying equations are probably correct and our weakness is in our poor knowledge of rates. In other words, the theory is sound, but we lack the required detail to make accurate predictions.

So, what role then does exploration and discovery have in oceanography?

We have described in detail only a small fraction of the global ocean. Of the 78% of our planet covered by ocean, most detailed oceanographic knowledge concerns a small fraction of the total ocean volume, representing surface, sun-lit waters, several hundred meters in thickness, and confined primarily to the exclusive economic zones of the worlds coastal nations. Globally, our knowledge of the ocean at depths below 500m is poor to nonexistent. While we would expect the basic laws of hydrodynamics and quantum physics to apply to the entire ocean volume, the same is clearly not true of biology. Take, for example, the unique life forms that have evolved around deep sea vents independent of solar energy. The life cycles of these organisms are completely unlike anything that we had observed prior to their discovery. Likewise, we know little of the important chemical reactions that take place in this environment of super-heated water and immense temperature gradients. As new technologies have emerged that enhance our ability to observe and survey the deep ocean, the rate of discovery has increased. Several times a year, for example, we hear of a unique, previously unknown, life form.

The first goal of a U.S. strategy for global ocean exploration, articulated in "The Report of the President's Panel on Ocean Exploration", is to map the important physical, geological, biological, chemical, and archeological features. It draws no clear distinction regarding the relative importance with regard to discipline nor does it identify specific geographic areas of the ocean on which to concentrate. These are important questions because we will always be limited in the amount of funds available for exploration. The metric for comparison is, in my opinion, the probability that an observation will be made that so completely disagrees with current theories and models that it triggers a re-evaluation of the underlying theory. The model can be anything of societal importance – environmental, economic, or strategic. Since we are dealing with the unknown, one way to guesses at such probabilities is to examine the number of observations made so far relative to the number of important discoveries.

Let me address each of these disciplines separately. Since I have argued that most of our oceanographic knowledge is derived from near-surface measurements, I will assume that any mission of discovery will concentrate on the deep ocean where our basic knowledge is poor. I will assign a numerical score to the number of observations (O) that have been reported in the open literature; 1 = few or no observations, 5 = enough observations to question a theory, 10 = enough data to construct and validate a model. I will also assign a score for the number of recent discoveries (D) that serve to excite the research community and/or society in general; 1 = few to none, 5 = a few over the past several decades, 10 = several each decade. The cumulative score then will be computed as D/O. The higher the cumulative score, the higher the priority within a global ocean discovery project.

Physical processes, the first discipline mentioned in the President's Panel report, would score a medium in observations since many CTD casts have been made into the deep ocean and we have at least some knowledge of deep-ocean currents by way of drifters. While the topic is important to global climate modeling and we do lack details regarding deep water mass formation, published observations have so far not confounded basic principles of hydrodynamics. One could argue that there may be small-scale processes associated with deep-sea vents that we have not thought of, but such processes can be reproduced in the laboratory and investigated in detail should the interest arise. Recent observations that call into question accepted models, such as Dr. Broecker's deep-sea conveyor belt, suggest that we need more detailed information about deep ocean circulation in order to adjust current models rather than to conduct a complete rethinking of the basic underlying theory. Therefore, O = 5, D = 1 and CS = 0.2.

Geology is the second mentioned science discipline, perhaps due to the potential economic benefit associated with any discovery. For similar reasoning, the international oceanographic community has directed significant funds to the investigation of deep-sea geology. The NSF Deep Sea Drilling Project, for example, currently directs $12M annually towards the collection and analysis of deep-sea cores. Discoveries in the past 50 years have greatly changed our ideas regarding the composition of and the geological processes occurring at the deep ocean floor; e.g., sea-floor spreading, plate techtonics, and the discovery of manganese nodules. Therefore, I assign the following scores: O = 10, D = 10 and CS = 1.

Most biological oceanographic research has been directed towards the near-surface, sun-lit areas of the ocean in support of fisheries commerce. Relatively few observations of deep-sea biology exist and what does exist is rich in information that has changed our view of life in the deep-sea and the range of

conditions under which life can exist. Information gained in the harsh conditions of a deep sea vent, for example, shapes our ideas about the origin of life on Earth and the possibility of life on other planets. And yet, the large percentage of new information in each deep-sea biological data set suggests that much more information is needed in order to adequately characterize the deep ocean. Therefore, O = 1, D = 10, and CS = 10.

Chemistry is next on the list in the President's Panel report. In many respects, chemical observations and discoveries are similar in nature to those in biological oceanography. Again, the most interesting observations seem to be in association with deep-sea vents; inorganic-based reactions that lead to mineral deposits and bio-chemical reactions that make life in that extreme environment possible. The number of discoveries are not as numerous as in biological investigations, but just as thought provoking. T suggest that O = 1, D = 5, and CS = 5.

Last on the list is archeology, our window into past human endeavors. Of all the disciplines listed, this one has the highest potential to stir societal interest. In fact, most of the funds that support archeological research come from private foundations and donations from private individuals. It is also the only discipline in which results rarely influence our future actions, only our view of the past. Archeological results may turn anthropological theories on their head, but even the most radical paradigm shift will be of little or no consequence in our present day-to-day activities. Most notable recent finds have emerged from Dr. Bob Ballard's expeditions to the Mediterranean Sea and the Black Sea. These observations have forced us to rethink our ideas about traditional trade routes at the dawn of history and the origins of myths and biblical stories. And yet, the ocean floor remains largely unexplored. Therefore, O = 1, D = 5, and CS = 5.

This analysis would suggest the following priority ranking, starting with the highest;

Biology	10
Chemistry	5
Archeology	5
Geology	1
Physics	.2

Given the availability of funds, perhaps concentrating on the highest priority issues is most appropriate. An ambitious science goal, for example, would be to simply catalog the abundance and diversity of life from the base of the sun-lit layer to the ocean floor. In my opinion, that would be about as ambitious as President Kennedy's 1961 proposal to congress to land a man on the moon by the end of that decade and the results would have a much higher potential to impact how we view our own planet and, perhaps, how we treat it in the future.

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Ocean Exploration suggested topics

1. Make four (4) new posters each year based on one or more projects. Include URL at bottom of poster.

Photo galley converted to a screen saver format. Download the new files - place a watermark with the Explore logo in the corner.
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2. Create access point for the OE program at **libraries**. The poster can be place above a terminal with Internet connectivity. This promotes understanding and recognition of the program among the general public

3. Plan a DVD archive and a DVD publication of underwater, atmospheric explorations. Film the "filmers" and other support persons on an exploration to promote secondary careers.

4. From the DVD publication series, compile a teacher/classroom package. Schools would love to have video related material. Schools cannot use the on-line access for video because the band-width is limited to the classroom.

5. Difference between basis research and ocean exploration

Basic research the outcome is dominant	OE the journey and personalities
science peer group	OE general public
complex, technical	OE direct, simple

6. Yardstick for success Number of People know about the program, common knowledge among a wide spectrum of general public

7. Outreach is essential Media, education,. Theme park links, museums, cruise ships and other affinity groups

8. Pathway from OE to basic research Track an idea developed in OE and then migrates to the professional science domain.

9. Partners in OE Academe Commercial NGO

10. International Governments Academe Tourist industry

11. Remote observations Web based access to real time explorations

Issue is bandwidth at remote locations US internally is no problem

12. Explain how the oceans/atmosphere operate within one theme.

13. Radio spots produced for NPR and other broadcasters.

14. Writer's conference for adventure writers to have access to the NOAA Explore assets and resource material

15. Next year (calendar year 2003) invert the primary themes and cross cut themes Tech and Outreach prime, then ocean dynamics and mapping as crosscut.

16. School kids to design explorer project like the science in space program at NASA has.

17. List the NOAA operational programs and NOAA science programs to the Explore topics funded or planned. Link the promotional to the functional as a progression to service to the public.

18. Create an *"Explorers' Digital Log"* as a publication vehicle for the observations as they are captured from the various *in situ* instruments, cameras and other direct methods of exploring. The log would be considered a digital publication so a citation would be created. The library would be ideal place to host the

service - a video screen, projector for large screen applications and other routing to NOAA offices at Silver Spring. Live feed into all conference rooms fromthe library would add new dimension to library services.

19. At future workshops capture the profile of participants by affiliation, category (government, academe, NGO, etc.)

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As we discussed on the phone, I was at the IOCARIBE (the IOC regional subcommittee for the Caribbean) meeting during your regional workshop in Miami. As a long-time physical oceanographic researcher in the Caribbean, and regional project coordinator for the Caribbean regional Ocean Observing System (IOCARIBE-GOOS), I have a few thoughts on potential Ocean Exploration projects in the region. Probably the most interesting, and highly relevant to Ocean Exploration objectives, would be a study of the active undersea volcano Kick 'em Jenny located about four miles north of the Island of Grenada. I have done two opportunistic surveys of the cone in 1996 and 2002, the latest with the Ron Brown's multibeam system (figure attached). The cone rises from 1500 m to within 180 m of the surface; the 1939 and 1974 eruptions sent debris above the sea surface. Given the active nature of the region (e.g. Pelee on Martinique in 1902, Soufriere Hills in Montserrat from1996 on), not only is KEJ likely to be the next Caribbean island, it poses a significant potential hazard to life and property throughout the region. I have been talking to volcanologist Haraldur Sigurdsson of the University of Rhode Island, who conducted studies of the volcano in the 1970's, and the University of the West Indies Seismic Research Unit in Trinidad about in-depth scientific studies of the volcano. I imagine Coral Reef exploration and mapping was brought up - this is definitely a priority regional issue, perhaps best suited to OE by exploring one of the more obscure regions using new remote sensing technologies along with in situ observations. You already did the connectivity issue last year; that's one of my pet interests and I wish we could have been involved earlier in that program. I am studying transport of waters through the Caribbean Passages. One of the major unknowns is what is happening in the circulation of the deep Caribbean. The Caribbean is a series of isolated basins which have trapped overflowing North Atlantic Deep water over a long time period; there is probably a lot of climate history here in the chemical and tracer composition of these waters, which are very poorly sampled. In particular there is little known about the deep overflow (or other transports) in the Windward Passage between Cuba and Haiti. I have been working with the Cubans and we did the only existing deep transport section there in 1996, there needs to be more long-term studies. Understanding role of the Caribbean on climate, North American Monsoons, and hurricane formation is needed, but not sure is OE material. Issue probably brought up and of OE interest is understanding of Caribbean whale populations, from Dominican Rep. through Eastern Caribbean not much known, potential for acoustic remote sensing.

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Hawaii Region

"... We are very interested in the new OE program (especially if we can get you interested in the territorial waters around Samoa!..."

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I realized that I had promised to send in some comments I got from local scientists to factor into your distillation of the workshop input. I think some if not most of what is included was mentioned, but I wanted to be sure that I followed through.

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Combined Comments from Some Hawaii Scientists

EXPLORATION NEEDS

1. We need to explore any areas left that haven't been explored and mapped, for relationship to current or future needs. For example, search for previously-unknown fissures, mineral deposits, lesser tectonic plate edges that could be involved in future earthquakes, new sealife or plant species or large numbers of existing species, etc.

OPPORTUNITIES

1. Assess quantities of species as a baseline for future comparison.

2. Establish environmental baseline for the world's oceans, to aid in future evaluations.

3. Establish a "belt" within the 200 mi. limit for controlled exploitation; i.e., mineral deposits, sand, power generation, offshore aquaculture, and medical/pharmaceutical solutions.

4. Select a site under the seafloor, offshore an unpopulated area for future nuclear waste storage. A site away from tectonic plate activity, that we can tunnel out 30 miles or more, and create a more acceptable storage than Nevada, or Alaska. It would create an economic boom for some area, maybe in the Gulf, or off Mexico or Canada.

5. Establish manned habitats on the seafloor which, like the space labs, will generate new technologies and interest in ocean exploration. The habitats should be placed in areas that need periodic monitoring, so records can be kept for environmental comparison.

PRIORITIES

1. Establishing a baseline for environmental change-monitoring, now and a century from now. This will be vital.

2. Establishing a nuclear waste site also is a vital need, and should be started soon.

II.

Briefly: far more satellite pop-off and acoustic tagging of fish needs to be undertaken in Hawaiian waters. We don't know where many of the fish important to Hawaii (Pacific blue marlin, swordfish, various tuna, giant trevally, sharks) come from, go to or do in the course of an average day/week/month/year. Without that information, we can't properly manage them. The technology exists and is well proven, what we need is the financial commitment to place thousands of high-tech tags in various species.

III.

One aspect of proposals and discussions with respect to ocean exploration is the lack of provision for taxonomy/systematics of marine organisms. Taxonomy/systematics in general gets tacked on to some biology courses, but rarely if ever is recognized in the curriculum I am appalled by the lack of interest of doing anything about learning names and identities of marine organisms -- or even how to go about putting names on what one finds, both within marine biology departments/ programs and among graduate students. I hope that in the proposed initiative there is opportunity for some concerted action to provide funding for the taxonomy/systematics that will be crucial to making sense our of the organisms that are going to show up in the proposed explorations.

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I felt obliged to voice some developing concerns about an important set of ocean observations that may be overlooked. Long term heat flow measurements on the ocean floor extending hundreds of kilometers normal to, and on either side of, rapidly spreading ridge axes (or hot spots) to determine the lateral extent of the heat "footprint" during intense episodes of sea floor spreading (or hot spot volcanism) that are current
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or may have occurred hundreds or thousands of years ago. Also of interest would be long term ocean-wide monitoring to see if there are correlatable ocean-wide fluctuations in heat flow. These might be related to core-mantle interaction that happened hundreds or thousands of years ago and are now just reaching the surface. Regardless of any theoretical speculations, long term measures of fluctuations in sea-floor heat flow may be a very important yet poorly understood data base.

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Maritime archaeology notes

1) folks seemed very interested in pinpointing locations. Shipwrecks are different from studying fish or widespread invertebrates. We have a list of around 200 commercial shipwrecks, and are currently working on a list of over 136 US navy ships and aircraft in the Hawaiian waters. Many of these are pinpointed by lat/long numbers already. It would have simply taken too much time to begin listing these wrecks site-by-site during the workshop. Additionally, the naval historical center is very careful (and often rightly so) with distribution of coordinates for its properties. As we have a grant from them to create an initial inventory, I would really have to check with them before releasing locations for wrecks.

Known locations prioritize targets...there are WWII submarines, torpedoed navy tankers, etc. in Hawaiian waters, each with a story to tell. None, though, have been confirmed by going back, diving on the numbers, and groundtruthing the target since its sinking. If I had to prioritize areas, the list would be something like Midway atoll environs (aircraft), Alenuinui channel between Hawaii and Maui, dumping grounds SW of Barber's Pt Oahu, historic defensive zone outside Pearl Harbor entrance, areas near shore to Lahaina, Honolulu Harbor, Hilo Bay, Waialua Bay, etc etc.

When targets came up in discussion during the workshop, people began naming individual items or wrecks which they had happened to hear about. To immediately jump to that scale of analysis is silly.

2) Smithsonian Institution (if not on the list of associated agencies for this topic) should be added. Dr. Paul Johnston has already done some work in Hawaii, curator of maritime history at the American History museum.

3) funding sources, after jotting down the basics, others piped up with "Discovery channel" and "National geographic." There is a reason those sources are not usually listed by professionals who are in the preservation and maritime history/archaeology field, and that is that a lot of survey and study does not revolve around media agenda. Popular perceptions of maritime archaeology include media sources, and oceanographers **…**, but beware of jumping to conclusions that [this] is representative of the field. **…** Real research designs are often slow, careful, and not geared towards producing daily flashy results for the cameras. There is nothing wrong with that stuff per se, but maritime archaeology research must be driven by professionals who have been trained in the field, or it will not be taken seriously by anyone except for network programmers.

4) Prioritization of targets is not really random, but something proscribed by federal preservation legislation, this is something quite different from the scientific method approach. Significance is defined fairly clearly by a number of federal documents. Spending money to look for a wreck which is not historically significant, even if it might be appealing to the media, can be seen as a waste of time. Have someone on board your planning team that knows preservation legislation, national register criteria as applied to ships, maritime history, etc.

I thank you for your emphasis on interdisciplinary multi-tasking exploration, for including non-scientific topics like maritime history and maritime archaeology. I'm quite interested to see how it really goes down.

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Alaska Region

Exploration Emphasis Area Identification and Prioritization

In terms of exploration, obviously the areas that are least explored are those that are more challenging to get to either logistically or economically, i.e. ice covered seas and areas that are served by "third world" ports. I suggest that these areas be the focus of the OE Program - areas where new discoveries are most likely to be made simply because the amount of prior information is sparse. This is not the easiest path, but it is the one that most directly addresses the aim of the Ocean Exploration Program. We already invest a great deal in research in US waters; this initiative can broaden our reach to a truly global perspective.

While I appreciate the political and economic challenges associated with working outside our EEZ, and especially in waters where the political climate is less stable and friendly than might be wished, I would point out that oceanographic processes do not recognize political boundaries.

Continuous water masses have currents, biota, contaminants, etc. that pass freely and interact regardless of anthropogenic lines. Our artificial division of these systems has minimized our understanding and slowed progress immeasurably ? while we understand pieces of near-coastal systems we will never have an integrated understanding of large scale processes unless we address them as such, not as bits that act in isolation. This is an especially pertinent issue in oceans like the Arctic and Southern Oceans where many nations have political interests. I am not suggesting that we risk scientists and resources in piratical waters (like the nearshore Gulf of Aden), but that if we cannot address systems holistically, simply for political reasons, that we put our resources elsewhere where we can do the science correctly. For example, in the near-coastal Arctic, we need studies that address poorly described regions near Russia - not more studies of the same areas that we know relatively well in US waters. Only with expanded coverage can we begin to address regional issues that are unique and pertinent to a fairly isolated ocean basin like the Arctic. If politics alter the path of the science, our support should be moved to areas where we can pursue the most relevant questions, not wasted in doing marginal work out of some misguided conception of "fairness." For Ocean Explorations to succeed and provide the most and best return for the investment, the science needs to drive it, not the politics.

Identification and Characterization of Exploration Strategies

The first need that any explorer has is for a map. Without this, discoveries cannot be placed in context nor communicated to others. The map may be a traditional bathymetric one, or a map of species diversity or of genetic variability, the commonality is that it provides a baseline for comparisons across space and time. "Mapping" does not compete well in traditional research proposals, yet its importance is fundamental. As the OE Program offers an opportunity for exploration (which also does not compete well in traditional funding routes), I hope it will also recognize the essential importance of maps and baselines to exploration, and to all science.

There is much technology that is currently available for oceanographic work, but it is underutilized by the scientific community because of cost and competition for scarce resources (e.g. the manned submersible Alvin and the remotely operated vehicle Jason are extremely oversubscribed, with funded researchers often waiting 2 years for field equipment time). Making these kinds of major resources available, either by supporting construction of new tools or by providing funds to rent commercially available items, would enhance scientific exploration. I would emphasize support for existing technology that is functional but unavailable, rather than development of new technology that in general requires a very long term and extremely large investment of funds before utility and functionality are achieved. There are many routes (commercial and defense) that support technology development. Much more can be done with existing tools, if they are made accessible.

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"...We are very interested in your program, however, as it relates to the discovery or exploration of submerged archaeological and historical resources in Alaska waters..."

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Good meeting you in Anchorage. I think the meetings were very productive. I only wish more (than one) biologist had been there. Attached is the figure I circulated showing age and spatial coverage of NOS hydro surveys in the eastern Bering Sea. The data were assembled with the assistance of Coast Survey's Don Haines and Steve Verry. LCDR Doug Baird called the other day to confirm that there is in fact a 780 nm2 hole (Bristol Bay) that has never been formally surveyed and added that the 1950s vintage surveys (most of the rest of the open water area) are at the 1:500K scale.

One final point. Although my EFH interests are pretty clear, I would like to suggest that the Bering Sea Fish Habitats Info Need/Gap should be broadened to reflect general exploration, this being an area with considerable national economic and global environmental (WWF designation) significance. As stated, the issue seems too parochial and agency-oriented. Also, please modify the Technologies section to clarify that interferometric side scan sonar (true swath bathy and true backscatter) is key to seabed characterization in highly-structured and variable areas of general low relief.

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"The main argument for OE studies in the Aleutian arc region (to include the deep trench on the Pacific side, the volcanically active Aleutian ridge proper, and slope and deep water regions on the Bering Sea side) come from the recognition that tectonic and volcanic activity in the region ensure that a single transect across the arc will encompass environments that are enormously diverse both physically and chemically. It is the physical and chemical diversity of these environments, and the near-complete lack of prior exploration in the region, that create the unusual opportunity to discover isolated and previously unrecognized biological communities in close geographic proximity."

Many thanks for your attention--I hope this short statement can help promote the Aleutian region as an area of interest to OE.

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This letter is to convey follow-up comments about the Alaska Regional Workshop.

As I studied the workshop report, three matters bubbled to my attention. One was an operational matter, and two were thematic opportunities that I did not think were exploited enough.

1) The operational or technical matter concerns the description of the "Standard Package". It seemed to me that for an exploration-discovery type program, which I like very much, that an essential part of the standard go-to-sea package should include a digital single channel seismic reflection system. A high resolution (portable) rather than a low-frequence system is what is needed. A signal-clean, gas-injector or water-gun source would be fine. Digital recording is a must so that seismic processing software packages can be used to clean up the records and extract acoustically useful field data.

2) Going to the first thematic matter, I thought that although a few words were said, I did not get a feeling that adequate emphasis was placed on hydrothermal vent hunting to locate isolated biologic communities and sea floor mineral masses. For example, many of the pull-apart basin located along the volcanic line west of, say, Kiska are likely habitats of hydrothermal activity. Exploration of Buldir and Ingenstrem Depressions, Prochoda (sp) scarp and related basins might prove exceptionally rewarding target areas for having a look. Years ago I recovered undatably young hornblende dacite from the northern crest
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of Ingenstrem Depression. So, the transform fault system out that way bleeds magma, some (maybe a lot) of which is "adakite" in composition. I smell black and white smokers everywhere.

3) With respect to exploratory studies of hydrate deposits, the central area (~3700 m water depth) of the Aleutian Basin (Bering Sea Basin) is underlain by virtually thousands of massive accumulations of methane hydrate. The hydrate masses in the sediment and the underlying columns of ascending thermogenic methane that feed them make for rather spectacular acoustic anomalies on seismic reflection records. The anomalies are called VAMP structures (Velocity-AMPlitude). The main mass of hydrate is several km in diameter, maybe 250 m high, and extends downward to the BSR (bottom-simulating reflector) located at a subsurface depth near 450 m. Reflection horizons overlying the massive hydrate deposits are blanked and broken up a bit, so it may be that methane is feeding through the gaps to the sea floor to nourish a benthic community. This is pure wonderment on my part, but taking a high resolution look at the sea floor above a VAMP structure could prove rewarding.

It's pretty clear that a great deal of methane is sequestered beneath the Aleutian Basin at VAMP structures. But no exploratory work has been carried out to map what one of these bodies looks like in 2D, let alone 3D. Although many thousands of km of digital seismic data are available (taken by USGS during the GLORIA cruise), no VAMP, as far as I know, has been crossed by two lines. The subsurface geometry of a VAMP structure is thus unknown. Mapping this geometry would be a juicy OE product with just all sorts of implications scientific and political (i.e, EEZ boundaries with Russians).

So, for the purpose of assessing the resource potential of VAMP structures (some VAMPs appear to involve a quantity of methane equivalent to that of a large gas field), their potential linkage to deep-water biological communities, and the amount of global-change gas stored in the Bering Sea Basin, exploration efforts to finally learn something definitive about VAMP structures would be a first-order program contribution. One can get started with planning this sort of work by calling upon the USGS archive of seismic data, which is large but has never been used to study hydrate deposits. Extracting information from this existing data set would be a great foundation for a masters thesis, the results of which would serve as the template and guide to conduct a cold-blooded exploration of one (or more) of these massive hydrate accumulations.

It is true that DOE is currently sponsoring a variety of efforts to explore and study methane hydrates, and this could be seen as a disincentive for Ocean Exploration to do hydrate-related exploration. However, virtually all of DOE's supported (and jointly with industry) investigations are for the Gulf of Mexico. This is true because industry is concerned about geohazards linked to shallow hydrate deposits in the gulf, where the oil and gas industry has a large financial stake. Because US industries do not consider (at least not yet) marine hydrate deposits as a resource (i.e., as a source of economically producible methane), nor are hydrates a global-change concern to them, and because US oil and gas companies, within the US EEZ, are not exploring for offshore resources outside of the Gulf of Mexico, DOE is accordingly not devoting research dollars for hydrate studies outside of the Gulf.

This circumstance leaves open a very large research-focused window of exploration opportunity for the EEZ of the Pacific, Bering Sea, and Arctic Alaska regions. For discovery investigations concerning large masses of hydrate, the Bering Sea is the place to go. Something interesting to note is the circumstance that hydrate deposits are commonly found (drilling and BSR studies) in slope deposits around the rims of most ocean basins. But slope sediment is in general pretty soupy stuff and lacks permeability and good reservoir characteristics. But if you can locate hydrate deposits in the sedimentary sequences of ocean margin basins, for example the Bering Sea Basin, the Sea of Okhotsk, and Sea of Japan, then you have a chance to accumulate hydrate in reservoir quality fan and basin-floor turbidite deposits. Things get very exciting if the basin-floor section is thick enough to produce thermogenic (petroleum) methane. Where this happens, which is the situation for the Bering Sea Basin, then exceptionally large quantities of methane hydrate can accumulate in the shallow subsurface.

Anyhow, for program planning purposes, consider that the opportunity to conduct hydrate exploration studies is wide open to NOAA's OE. Neither DOE, the USGS, nor the NSF is interested

(except, perhaps, for the Office of Polar Programs). The Japanese, however, might be interested because they are keen on discovering producible methane deposits along the Pacific rim.

I truly hope that NOAA's OE program does well. When a program's mission is to explore frontiers, discoveries will happen--again, again, and again. It's rather sad that my old organization (USGS) turned away from this critical element of their public mission. As you know, except for some minor efforts, the ocean floors of the EEZ, in particular for the Alaska offshore, have been abandoned for the shorelines of the lower 48 and Hawaii. I'm just happy that NOAA has picked up the challenge to make discoveries in the offshore waters both shallow and deep.

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TRANSECT ACROSS THE ARC

I am really intrigued by concept of doing one or more transects across the Aleutian Arc plate boundary, as discussed at the workshop. I think this is very compelling as a framework for an interdisciplinary OE expedition -- in a dynamic environment, in an area of the US EEZ that is ripe for exploration. In fact, there are very good reasons to do either two or three transects (explained below).

The transects would cross from the Pacific Ocean into the Bering Sea, starting from structures on the downgoing Pacific plate and crossing over to the backarc in the Bering Sea (the limit of active volcanism, north of the volcanic islands and beyond the limit of tectonic activity). There are clear candidates for exploration in deep trench biology, structural geology, volcanology, potential for hydrothermal venting, biology and physical oceanography in the shallow passes between islands, etc. During the workshop we mainly discussed the middle part of the transects, i.e., the volcanic arc, the Aleutian Ridge, the shallow passes between the Pacific and the Bering Sea, the deep rifted canyons. To elaborate on other features that could be crossed by transects:

structures on Pacific plate: Large structures on the Pacific plate just south of the Aleutian Trench have been identified in GLORIA images. They are interpreted as fault blocks created by bending in the Pacific plate as it enters the trench. These structures may be associated with seafloor fluid seeps and/or volcanism. Bob Duncan et al. found "young" volcanics on Patton Smt (western Gulf of Alaska) during ALVIN dives in 1999; Patton Smt is in a similar setting, though farther from the trench, and Duncan et al. think the volcanism there has been triggered by deformation as the seamount approaches the trench. Could be included in the south side of "transects."

flank failures & debris slides: The north flanks of five (out of six) volcanoes along a 135-km section of the central Aleutian arc have fallen into the sea. From west to east: Tanaga, Boborof, Kanaga, Adagdak, Great Sitkin. The scars are evident in the shape and stratigraphy of the volcanoes on the islands, and large debris fields out on the floor of the Bering Sea can be seen on GLORIA images. The circumstances of these flank failures are unknown, except that they are not related to caldera collapse - they are classed as debris avalanches, and may have caused tsunamis when they occurred. When did they occur (how closely spaced in time, and how catastrophic?). What was the trigger (some tectonic event such as enormous earthquakes, or sudden tilting of the islands?). This topic was not mentioned at the workshop, but is one that the Alaska Volcano Observatory geologists are actively interested in. It is also a topic that bridges between the Aleutian Islands (with which people are more or less familiar) and the unknown region offshore. Could be included in the north side of "transects."

cold seeps & hydrothermal vents: The high likelihood of cold seeps in the Bering Sea and along the southern margin of the Alaska Peninsula is paired with an equally high likelihood of hydrothermal vents in the Aleutian Arc. This unusual geographical proximity presents an opportunity to compare the biology at hydrate-driven cold seeps with biology at nearby arc-driven hydrothermal vents. Many (most?) of the organisms at hydrothermal vents are thought to have gone extinct in the late Cretaceous, and then re-radiated out from cold seep environments -- biologists say that the two are genetically and evolutionarily related. But this is based on studies at mid-ocean ridges and continental margins, geographically very far apart. Is there a closer (and possibly more recent) evolutionary relationship, or possibly even direct
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exchange, where the two settings are in close geographic proximity? This is something that was brought up at the workshop, but I'm not sure the idea got across.

comparison of transects across the eastern, central, and western Aleutians: Several major characteristics of the physical environment change dramatically from east to west along the 2500 km long Aleutian Arc. The most obvious is the convergence angle between Pacific and North American tectonic plates, controlling the volume of volcanism and amount of tectonic dismemberment; hence the whole character of the arc changes systematically from east to west. Another is the volume of sediment input to the trench. Sediments from the North American continent are transported westward along the trench approximately as far west as Amlia; beyond that, the trench seems to be sediment-starved. I don't know enough about the biology to say, but I suspect that it varies with distance from the major landmasses (and fishing ports), if nothing else. The forcing functions vary so strongly along the arc that doing a transect of just one locality misses the potential of the Aleutians. The eastern part of the arc is at least closer to the main North American landmass, and hence has seen at least some exploration. The central and western parts of the arc are big question marks; studying these areas would advance the general state of scientific knowledge about one of the most under explored parts of the plate margin system.

native community input: The central part of these transects would of course cross the shallow Aleutian Ridge, where the Aleuts have traveled, fished, etc. for thousands of years. Involving them as advisors and participants in exploration of this area would be a natural way to recognize this segment of the population. This is a sensitive issue in AK.

VERY DEEP DIVING VEHICLES - JASON II

During the discussion about exploration of the Aleutian Trench, JAMSTEC was mentioned briefly as a potential collaborator. There did not seem to be any special interest in working with JAMSTEC, only a recognition of the need for very deep vehicle capability. However, after the meeting I was reminded that the new JASON II has a 6000 m depth limit. I would much prefer to see OE rely on JASON II for studies in the Aleutians.

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West Coast Region

I'm interested in data that exist or might be gathered on the abundance of species occupying subtidal rock substrates in Washington and Oregon, especially benthic invertebrates. This specific interest stems from a more general interest in effects of isolation by distance on colonization and persistence of populations.

Thus far, I have found no references to published surveys of representative sites but haven't yet searched technical reports. If this habitat is as understudied as it seems to be, it is a remarkable gap in knowledge of biota of the continental shelf.

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Workshop ideas for Outreach and Education

I attended the Monterey workshop to represent education interest in OE planning. Thought we didn't discuss education to any great degree there was widespread support and inclusion for it. I did manage to talk briefly with the OOE staff but since then I have some additional ideas, thought and suggestions.

One suggestion that came out of our group discussion, which I strongly encourage, is the idea of holding an OE education summit(s) and planning session. I also strongly recommended that in the future the education summit should happen at the same time and as part of these regional workshop so there could be an exchanged and sharing of the ideas and needs between the educators and researcher. I think having separate workshops perpetuates the "its not our thing" mentality. I personally got a lot out of listening and

being apart of these workshop sessions. I think researchers would also get a lot out of listening and being apart of some education planning sessions. In my opinion it shouldn't be just one educator like myself at these workshops or one researcher participating in an education summit session. Ideally this would be a combined workshop when there is an assemblage of educators and researchers. It could be as simple as adding another break out session focused on outreach education and having the ideas presented to the whole group.

There is no doubt that the OE program is committed to education but there is a need for clarity on what the education strategy is and who is the audience. If the need for the program is to gain public support then the educational strategies and audience maybe different from the traditional K-12 approach. Clearly this program can't address all the educational needs or ideas. What is needed, however, is to figured out where the program can make the biggest difference and contribution toward ocean science education while at the same time raise awareness and support. I think an education summit(s) could help identify this kind of focus as well as harvest the many great ideas and needs similar to what is being done in these workshop.

Another aspect of OE education that I thought about after the meeting is the challenge the PI's have to include outreach and education in their proposals. Often it is thrown in at the last minute or is an assemblage of ideas or just a very basic and traditional outreach approach. Outreach and education is becoming more and more important for competitive proposals. It seems that there are a couple of approaches that OE can take with this. One approach is we (education community) all work individually with PI's and get included on their proposals. For the most part this seems to be what is happening now. Another approach might be to figure out a more coordinated way to include outreach and education that serve the needs of both the PI and educators. I don't have any specific ideas but it might be an interesting discussion to have with the researchers, educators and the OE staff.

I understand that there are educators on the proposal review panel. This is great and I am curious how the outreach and education components are weighted and if a criteria has been developed. It seems like more involved efforts should score higher than less complex traditional O&E. This might be a contribution that OE can make for other proposal review process if it hasn't already been developed. I believe that with this increasing requirement for O&E in proposals is developing a need and an opportunity to provide researchers and the education community with new skills, resources, services, networks, and coordination.

Other thoughts and ideas include:

-Use the education funds to leverage and match more funds from other agencies or NGO's.

-Develop an auditorium presentation about OE and the various projects that can be distributed to public facilities with auditoriums. Maybe provide small grants for purchasing hardware for those places that are willing to include this into their programming but may not have the system to support it.

-Develop a kiosk that present OE and the various projects that can be mass produced and placed in aquariums, visitor and science centers, school lobbies or banks and building lobbies. This kiosk would serve as an brief attraction to the program and direct people to the website and other resources to explore more. These kiosk can be produced inexpensively in quantity and could be widely distributed for no cost or low cost. The kiosk could also be designed to continually update itself by accessing data files from a single or multiple server sources. These could be stand alone units or if accessible to a phone line connected to the web. The kiosk could also be part of the trade show style display, part of a table top display, or it stand alone.

-Education programs and service need to work or be included in the designing of the Data Archiving system.

-If OE wants to reach teachers then resource are needed to pay for release time, stipends etc.

-Create a simple exhibit development kit that could be used by classrooms, small interpretive center, and even large aquariums. This kit has instruction to build a table top or larger exhibit. It also has options and costs associated for each type with step-by-step plans, materials list and access to text and image materials. Perhaps these can be made available through the web or pdf files. If higher quality images are needed maybe the OE can provide the images, maps, etc. The OE could also provide advertising and marketing materials to promote the exhibit or display for those who participate and develop one of these displays. The kit could also provide templates that can be printed off, traced, cut out, and used for fabrication. The History of Ocean Science on the web site is a good example of the source material for exhibits and displays. Perhaps small grants could be made available to smaller interpretive centers. This kit could be designed to be adaptable for each project and PI's could include this in their proposal as a part of the O&E package. The small grants could go to those groups who are committed to working with these PI's.

Develop and electronic curriculum that has access to parts of the data from expedition and creates a free choice learning (i.e.. exploration) of Ocean Science and is used in a structure learning environment (i.e.. formal education) The electronic curriculum sets up learning objective but how they are met is up to the students own exploration verses the teachers directing a whole class activity. The teacher facilitates exploration and discovery. The OE program would be a natural subject to experiment with this kind of approach. This is also a blending of informal and formal education.

Use facilities like the Aquariums and Science Centers as NODES to reach a network of schools, marine educators and interpretive centers. Coastal America has a network call Coastal Ecosystem Learning Centers. The strength of these centers are the regional connections and networks to other groups and programs. OE might be able to provide resources to develop and strengthen these links and networks by sponsoring regional networking workshops or supporting the development of a consolidated resource directories of education and OE research for each region.

Hold student ocean conferences at these nodes or in the Ports from which the expeditions travel through. We just held a Coastal America Student Ocean Conference that focused on Marine Protected Areas. This was a successful event with 50 student. An OE student conference could be done in a manner such that students could meet with the scientist for an expedition debrief session. If OE is planning to have public and media events as it has in the past this could be an added element to these events. OE would need to provide some funds for coordination of the event and student travel (in some cases) to attend.

Hopefully some of this is useful and it makes sense. I would be glad to talk to you more if you have any questions, need clarification, want to hear more about the meeting, or discuss ideas.

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North Atlantic Region

Where is the Line Between Exploration and Research?

NOAA's new Ocean Exploration program presents exciting opportunities for unimagined discoveries and understanding of the ocean realm. Traditionally, most discoveries in the ocean have been serendipitous encounters made during the course of research funded through normal funding channels. For example, discovery of hydrothermal vent communities was made during geological investigations of ocean spreading centers. New species are routinely collected during hypothesis driven work on marine communities or during routine characterization of various parts of the ocean. We now have an opportunity to conduct ocean voyages focused on discovery, an opportunity not widely available for nearly half a century.
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Proposing and designing projects for such voyages can be confusing for the research community and problematic for program managers. For example, what agency and program should fund such proposals --when should a proposal be sent to OE, versus NURP, versus NSF? For the sake of both the individual programs and the scientific communities they fund and represent, all extramural programs should articulate a dividing line (or perhaps more realistically, a gray zone) between OE activities and those of other national programs (e.g., NOAA's NURP, NSF's SGER). Such groups in the past have routinely supported both exploratory and hypothesis driven research.

Where does exploration end and hypothesis driven research begin? Webster's Seventh New Collegiate Dictionary defines explore as:

> a "search through or into, to examine minutely especially for diagnostic purposes, to penetrate into or range over for purposes of geographic discovery, to make or conduct a *systematic search*" and research as.
>
> "*careful or diligent search*, studious inquiry or examination, investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts or practical application of such new or revised theories or laws."

There is no clear division in these definitions and one could look at exploration and research along a gradient of systematic inquiry.

The President's Panel on Ocean Exploration defines exploration as "… discovery through disciplined diverse observations and the recording of the findings." Further, the report distinguishes an explorer from a researcher " … by virtue of the fact that an explorer has not narrowly defined the observing strategy to test a specific hypothesis." However, the description of exploration that follows goes full circle by adding, "[a]nswering questions and following up on ideas will still be cornerstones of the new program." Further, the report states that "[w]hile hypotheses may be less specific, and their outcome less predictable than the current norm, the observations will be more broadly based, and the program more interdisciplinary." The end point here is clearly that hypothesis driven work will still be supported, albeit perhaps based at least on straw man hypotheses, and provides little insight for defining a boundary.

So, how do we proceed in defining exploration and its place in federal ocean programs? One direction could be based on a division between observation and experimentation. Observational programs, those that seek to define pattern in the natural world, fit nicely in the realm of exploration. This leaves experimental studies, those requiring manipulation and replication, to the traditional funding sources. Another direction could be based on the specificity of hypotheses. Both avenues seem to present a scale for finding a dividing line. How do we advise investigators where such a line is, and more importantly, is this a line we wish to draw? From the perspective of NURP, we have supported all types of scientific inquiry: studies defining pattern based on systematic observation; experimental studies based on manipulation and pattern recognition; experimental studies based on a priori hypotheses; and both pattern recognition and experimental research based on hypotheses that are narrowly defined. The ability to construct a priori hypotheses simply reflects knowledge of existing paradigms such that new discoveries can be set within some scientific context. Narrowly defined hypotheses can be viewed as a reflection of more specific knowledge such that null and alternative hypotheses are based on a clear set of narrow predictions.

The multidisciplinary nature of "exploration" as defined by the President's panel perhaps can provide a key and dividing line that may aid in directing investigators to one program or another. However, this will also require understanding of the context of "multidisciplinary" studies. For example, does a cruise with specialists in community ecology, population genetics, and behavioral studies, all areas of biology, constitute an interdisciplinary study or must the science party have a biologist, geologist,

physical oceanographer and meteorologist? Given the wide breadth of any discipline, I posit that there are few individuals who could be ready to identify all of the possible serendipitous discoveries in any particular region of the ocean. In any case, exploratory work should involve some level of multidisciplinary team to meet the gauge for an "exploration" proposal. Something may also be gained by emphasizing the distinction between multidisciplinary and interdisciplinary-- the former, within the context of this discussion, implying a cruise with a wide range of disciplines in order to "cover all the bases," while the later implies a group of scientists working on a single project from multiple perspectives. The former being the nature of an exploratory team, while the latter being more akin to modern oceanographic research teams.

This leads us to the issue of systematic observation as the fundamental tenet of voyages of discovery. Just as NASA's planetary explorations by humans and robotic vehicles field teams of scientists to develop a set of observations that can be made within the limits of spacecraft weight, time, and money, so too can oceanic voyages be planned and implemented within such a context. We can identify areas of the world's oceans where little is known and develop targeted cruises to collect sets of samples and data. The types of collections and methods required for such collections can be made by a wider group and implemented by the science party at hand. Perhaps scientists (and others such as educators and artists) can rotate through the cruise legs, allowing full participation by those willing to invest time and energy in such endeavors. The products of such cruises can then feed a range of disciplines and allow the scientific community to use the results of these cruises to better understand pattern and process in the ocean. Collections could be focused on characterizing broad biological, geological and physical oceanographic characteristics at each station and improved high resolutions maps could serve as guides for subsequent experimental, process-oriented, hypothesis-driven research.

There is purposely no conclusion here, although I have my own opinion. This leaves us with questions that require consensus to answer: Can we articulate a difference between exploration and research? Perhaps more germane, do we want to articulate such a dividing line? We need to consider our constituents but we also need to consider how such decisions could affect the ultimate directions of our programs.

A logical next step, however, could be to utilize the upcoming Ocean Exploration workshops as critical venues to engage the ocean community in further refining these distinctions. Just as the Oceans Commission is traveling around the nation, meeting and discussing with a broad set of users to set the future directions for all of the oceans, so too can Ocean Exploration reap the collective wisdom of hundreds of dedicated members of the community to help forge the direction of Ocean Exploration in the coming decades.

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Great Lakes Region

Generally film footage of lake bottoms is always useful.

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Here are a few thoughts on Great Lakes cultural resource explorations. I was unable to make the trip.
Great Lakes Unique factors

- Relatively small area
- Not deep by ocean standards

Extraordinarily high density of historic submerged cultural resources. For many decades the worlds busiest industrial waterway.
Excellent site preservation (threatened by environmental/human activity)
Major periods of historic significance as far as the density of archaeological remains 1820-1920.

Density of wrecks reflect complex processes in North American history. Best analyzed part of a series of interrelated chapters in North American History.
Some suggested historical themes
Native American Cultures
The Fur Trade
International Military Action
Westward Migration
History of Technology (diffusion of technology/environmental affects on technological design)
Industrial America
More than in other regions cultural resource explorations must be managed.
Isolated or individual programs of shipwreck discovery threaten to destroy the cultural resources that are needed to create the new questions that are at the heart of the discovery process.
Priorities
1. Environmental assessment of shipwreck sites. How is the environment affecting preservation? Key issue, factors affecting site stability This is necessary to prioritize explorations.
2. Native American/Paleo-Indian Sites. A largely untapped area.
3. Pre-1870 passenger steam vessels
4. Schooners
    a. 1800-1820
    b. 1820-1845
    c. 1845-1865
    d. 1865- later
5. Bulk Carriers 1869-1900
6. Non-Shipwreck coastal sites (mills, docks, etc.)

How.
1. Regional Exploration/Survey
2. Data Mining
3. New Techniques for low/medium cost non- or minimally destructive archaeological investigation
4. New methods for site monitoring and protection/ Site stabilization
5. Curation and conservation facilities and technologies.
6. Identification of regional experts.

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South Atlantic Region

"...Per your recommendation, I am submitting written comments that address needs, opportunities, and priorities for exploration of coastal and oceanic regimes."

Needs

Understanding and predicting how living organisms thrive in the ocean interior are difficult tasks. Future progress in understanding biological processes in the deep ocean will depend on in situ investigations that carefully organize objectives and deploy novel tools and technologies in representative environments. It is well-recognized that traditional, remote approaches to study the water column phenomena, i.e., deploying instrument packages from ships and using satellites and buoys to monitor changes, are blind and need to be sea-truthed. There are at least two ways to remedy this fundamental problem. Conduct short-term, small-scale investigations by using undersea vehicles to conduct detailed observations and pertinent experiments. Establish long-term, multi-scale explorations by developing undersea observatories to monitor critical events.

More cross-disciplinary transfer between physical, chemical, and biological oceanographers is essential. For example, it has been clear for a long time from in situ observations that the oceans are multi-layered, in physical, chemical and biological dimensions. The "new" discoveries of thin layers made with innovative profiling technologies that are deployed from ship or autonomous platforms need to be sea-truth with in
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situ interventions. Such research would guide the development of predictive models about topics such as biodiversity, food web dynamics, carbon transport, remineralization, bioturbation, and diagenesis.

Greater use of manipulative field experiments are required to record rates and fluxes in deep-water environments in order to define mechanisms that regulate dispersal strategies, e.g., fluid and hydrophylic variables that serve as cues for larval transport and settlement.

Intervention with manned and robotic vehicles capable of recording high-resolution images and conducting controlled experiments are needed to investigate episodic events (e.g., harmful jellyfish blooms), invasions of exotic species (e.g., food web disruption), and particle transport processes (e.g., large aggregate flux).

Opportunities

More frequent and more widespread opportunities to use of undersea vehicles to enter ocean environments (=depths beyond those possible with scuba diving) are clearly necessary. The lack of extensive support for both direct access to the uppermost 2000 m with undersea vehicles and for technical improvement of diving platforms capable of operating to 2000 m has limited ocean exploration for decades.

Priorities

General:

Provide greater access to ocean environments with manned and robotic vehicles.

Support extensive development of state-of-the-art instruments (e.g., cameras, sensors, lasers) and tools (e.g., devices to samples biological, chemical and geological materials) that can be deployed with undersea vehicles or moored at specific undersea locations.

Specific (One subset of the projects that should be given priority):

Map biodiversity, vertical distribution and relative abundance of gelatinous zooplankton (i.e., ctenophores, siphonophores, medusae, salps and appendicularians).

Identify intra- and interspecific trophic relationships of gelatinous zooplankton.

Investigate life history strategies (e.g., fecundity, growth rates, overwintering, prey selection, advection) for the most numerous gelatinous zooplankton species.

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South Atlantic Region

Atlantic Ocean, south of Hatteras

Just a few thoughts:

1. Gas/Oil Reserves and Conservation: NC and US has a region (this is right on the edge of north and south of Hatteras divisions) with potential for oil/gas deposits. Some of the tracks have been leased, but no exploratory drilling has occurred. This is in the EEZ, just on the continental slope, near the confluence of the Gulf Stream and Labrador Current, known The Point. Questions have been raised about the stability and sediments of this area, benthic life, and currents. Some oceanographic research has addressed these points, but not much. If this area becomes open to drilling, it would be a good idea to have some more data. Education should have more information and visuals about this area from the surface and upper water column abundance and biodiversity, to benthic life to sediments in order to allow students and citizens better access to data, options.

2. Non pelagic living resources: The deep coral growth and the “hard bottoms” on the Gulf Stream side of the continental shelf are fairly unknown. Some of these area which are in 600 feet of water and more, are
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possible spawning grounds for some grouper species. The extent of the hard bottoms, outcrops and corals (cold water, no zooxanthellae) would be fascinating for extending student knowledge of scarcely known ecosystems.

The book, Ship of Gold in the Deep Blue Sea, by Gary Kinder raises all sorts of questions about shipwrecks and identification/salvage technology in deep ocean off South Carolina to Bahamas. Some of the deep water mollusks (slit shells) and sponges have different life styles from shallower creatures which would be interesting if good videos were available.

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Deep environments along the Florida Reef Tract merit consideration for exploration. Of particular interest are potential sites for reef fish spawning aggregations, which may need to be evaluated for additional protective measures. A good example is Riley's Hump, south of the Dry

Tortugas, which has been protected within a marine reserve since July 2001 (Tortugas Ecological Reserve, South: http://www.fknms.nos.noaa.gov/tortugas/currentplans/implementation.html).

We know little about sites for spawning aggregations in and near the Sanctuary.

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5 List of Workshop Invitees

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Great Lakes	Trefor B. Reynoldson	Ph.D.		Chief	National Water Research Institute Environment Canada Acadia Centre for Estuarine Research Box 115 Acadia University Wolfville, Nova Scotia B0P 1XO CANADA	trefor.reynoldson@acadiau.ca trefor.reynoldson@cciw.ca	(902) 585-1638	(902) 585-1054
Great Lakes	Mike Ripley				Chippewa-Ottawa Resources Authority	mripley@northernway.net		
Great Lakes	Raymond Robichaud			Military Deputy	Naval Research Laboratory - Bldg. 1009 Stennis Space Center, MS 39529	robichaud@nrlssc.navy.mil	(228) 688-4014	
Great Lakes	Steve Ruberg		Y	Group Leader	NOAA Great Lakes Environmental Research Laboratory Marine Instrumentation Lab 2205 Commonwealth Blvd. Ann Arbor, MI 48105	steve.ruberg@noaa.gov	(734) 741-2271	(734) 741-2055
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Great Lakes	James H. Schlender			Executive Administrator	Great Lakes Indian Fish and Wildlife Commission	jschlndr@glifwc.org	(715) 682-6619	
Great Lakes	David J. Schwab	Ph.D.	Y		NOAA Great Lakes Environmental Research Laboratory 2205 Commonwealth Blvd. Ann Arbor, MI 48105	david.schwab@noaa.gov schwab@glerl.noaa.gov	(734) 741-2120	(734) 741-2055
Great Lakes	J. Ashley Scott	Ph.D.		Director	Great Lakes Institute for Environmental Research University of Windsor Windsor, Ontario N9B 3P4 Canada	jascott@uwindsor.ca glier@uwindsor.ca	(519) 253-3000 x2732	(519) 971-3609
Great Lakes	Thomas Skinner				Illinois Environmental Protection Agency	skinner.thomas@epa.gov		
Great Lakes	Rudi Strickler		Y		Great Lakes WATER Institute 600 East Greenfield Avenue Milwaukee, WI 53204	jrs@uwm.edu	(414) 382-1740	
Great Lakes	Kathy Sullivan	Ph.D.		President and CEO	COSI 333 W. Broad Street Columbus, Ohio 43215	http://www.cosi.org	(614) 629-3105	

Region	Name	PhD/ Rank	Attend	Title	Address	Email Address	Phone Number	Fax Number
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Great Lakes	Glenn Warren				EPA GLNPO 5623 53rd Avenue Kenosha, WI 53144	warren.glenn@epamail.epa.gov	(312) 886-2405	(312) 353-2018
Great Lakes	Nigel Wattrus				University of Minnesota 10 University Drive, 215 RLB Duluth, MN 55812	nwattrus@d.umn.edu	(218) 726-8128	(218) 726-6979
Great Lakes	Anne Wright		Y	Assistant Director	Great Lakes WATER Institute 600 East Greenfield Avenue Milwaukee, WI 53204	arwright@uwm.edu	(414) 382-1707	
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South Atlantic	Christopher Amer				State Underwater Archaeologist Columbia, SC	Amerc@sc.edu		
South Atlantic	Jerald S. Ault	Ph.D.			University of Miami RSMAS/Division of Fisheries 4600 Rickenbacker Causeway Miami, FL 33149	j.ault@miami.edu	(305) 361-4884	(305) 361-4791
South Atlantic	Charles Barans	Ph.D.			SC Wildlife & Marine Resources Department Marine Resources Research PO Box 12559 Charleston, SC 29422	baransc@mrd.dnr.state.sc.us	(843) 762-5084	(843) 762-5110
South Atlantic	Dick Barber				Duke University Nicholas School of the Environment Marine Laboratory 135 Duke Marine Lab Road Beaufort, NC 28516-9721	rbarber@duke.edu	(252) 504-7578	(252) 504-7648
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South Atlantic	Reed Bohne			Manager	Gray's Reef National Marine Sanctuary 10 Ocean Science Circle Savannah, GA 31411	reed.bohne@noaa.gov	(912) 598-2345	(912) 598-2367
South Atlantic	Joe Bonaventura				Duke University Nicholas School of the Environment Marine Laboratory 135 Duke Marine Lab Road Beaufort, NC 28516-9721	joeb@duke.edu	(252) 504-7613	(252) 504-7648
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Region	Name	PhD/ Rank	Attend	Title	Address	Email Address	Phone Number	Fax Number
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South Atlantic	Clayton B. Cook	Ph.D.			Harbor Branch Oceanographic Institution ECOS 5600 U.S. 1 North Fort Pierce, FL 34946	ccook@hboi.edu	(561) 465-2400	(561) 468-0757
South Atlantic	Jon Coon		Y		PADI, Mid-Atlantic Regional Manager 109 Rockbridge Close Easley, SC	jonc@padi.com	(864) 859-1469	(949) 858-4338
South Atlantic	Reide Corbett	Ph.D.			East Carolina University Department of Geology Coastal Resources Management Greenville, NC 27858	corbettd@mail.ecu.edu	(252) 328-1367	(252) 328-4391
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South Atlantic	Robert Diaz	Ph.D.			College of William and Mary Institute of Marine Science Maury Hall, Room 105 Gloucester Point, VA 23062	diaz@vims.edu	(804) 642-7364	(804) 642-7097
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Region	Name	PhD/ Rank	Attend	Title	Address	Email Address	Phone Number	Fax Number
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South Atlantic	Brian D. Keller	Ph.D.			Florida Keys National Marine Sanctuary PO Box 500368 Marathon, FL 33050	brian.keller@noaa.gov	(305) 743-2437	(305) 743-2357
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South Atlantic	Jack Sobel				The Ocean Conservancy Director of ECOSYSTEM Programs 1725 Desales Street NW, Suite 600 Washington, DC 20036	jsobel@oceanconservancy.org	(202) 429-5609	(202) 872-0619
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South Atlantic	Elizabeth Von Kolnitz			Assistant Director	Public Affairs, South Carolina Department of Natural Resources PO Box 12559 Charleston, SC 29422	vonkolnitze@mrd.dnr.state.sc.us	(843) 762-5400	
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Region	Name	PhD/ Rank	Attend	Title	Address	Email Address	Phone Number	Fax Number
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6 Attendance Statistics

Regional Ocean Exploration Workshop Statistics – February 25-April 11, 2002

Geographic Region	Attendees	City
Caribbean	22	Miami
Gulf of Mexico	23	Oxford
Hawaii	20	Honolulu
Alaska	14	Anchorage
West Coast	20	Moss Landing
North Atlantic	25	Avery Point
Great Lakes	19	Milwaukee
South Atlantic	13	Charleston
Total	**156**	

All Attendees Breakout	**Caribbean**	**Gulf of Mexico**	**Hawaii**	**Alaska**	**West Coast**	**North Atlantic**	**Great Lakes**	**South Atlantic**	***Total***
Academia	11	9	5	4	2	9	10	5	**55**
Federal	9	12	8	8	10	8	4	6	**65**
Industry		1	1	1	2	1	1	1	**8**
International			1						**1**
Local Government							1		**1**
Museums & Aquaria			1		1	3	1		**6**
Non-Profit	2	1	2	1	4	1	1		**12**
Private Citizen						1			**1**
State			2		1	2	1	1	**7**
Total	**22**	**23**	**20**	**14**	**20**	**25**	**19**	**13**	**156**
Federal Breakout ~ Attendees / Invitees									
DOC	9/13	8/18	8/23	6/16	9/24	7/18	3/16	6/21	
DOE	0/4	2/3	0/3	0/1	0/4	1/3	0/2	0/4	
DOI	0/2	2/5	0/3	2/8	1/5	0/1	1/1		
DOS			0/1						
EPA	0/1			0/1		0/1	0/3		
NSF	0/1	0/1	0/1	0/1	0/1	0/1	0/1	0/1	


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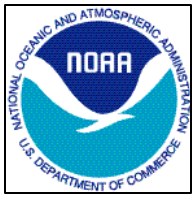
UNITED STATES OF AMERICA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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE